SDWN

Our design Github link: https://github.com/st21621147/UAV-SDWSN

Software Define Networking (SDN) compare to Traditional networks

Traditional networks

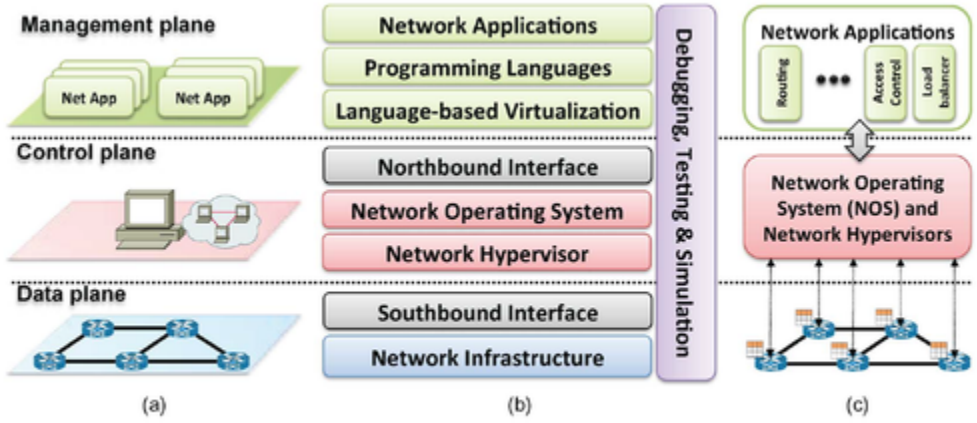
vertical integration (combine control plane and data plane together) router, switches

SDN

separating network control and underlying routers and switches

SDN is a logically centralized system not postulate a physically centralized system.

programmable feature, the logical centralization of network control



Software-Defined Networks in (a) planes, (b) layers, and (c) system design architecture.

Three planes:

data plane: forwarding data

control plane: the protocols used to populate the forwarding tables of data plane elements.

management plane: software services. network policy is defined in management plane, the control plane enforces the policy, and the data plane executes it by forwarding data accordingly. (running applications)

Applications

routing, firewalls, load balancers, monitoring.

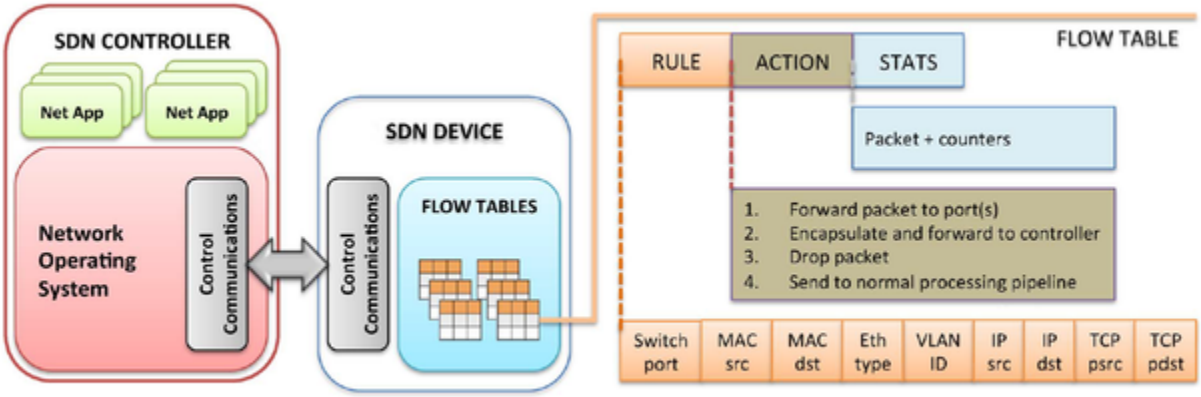
SDN advantages

improve flexibility and easy to maintain and upgrade network.

take advantage of global information

control plane: decides how to handle network traffic

data plane: forwards traffic according to the decisions made by the control plane.



. 7. OpenFlow-enabled SDN devices.

SDN need to **define** programming **interface** between data plane (switches) and controller.

The most notable example is **OpenFlow**.

SDN scalablity, security, dependability.

Software define wireless networking

Challenges

Reliability: wireless communication is unstable, suffered by surrounding environment interference.
Energy: nodes often battery powered and difficult to recharge, energy consumption is important metric.

Memory and computing ability limitation: data plane in wireless networks often has small memory and limited CPU speed. It can not save a lot of flow tables and fast traverse tables.

Motivation

Why sensor network needs software define networking?

Nodes may die and move, network need **update** routing frequently. Box-by-box update is unrealistic in sensor network.

SDN reduce **energy** consumption of sensor by decoupling computing load from sensor nodes to control plane,. Designing **more energy efficient routing protocol** base on global information.

Resilience to network dynamically change (eg. node died).

Global optimize routing table to improve throughput and reduce latency.

Easy to mannage network: By using **standard interface** to configure network, user need not know the low-level vendor-specific instruction.

Different applications need **different rules**. some applications need energy efficiency, some need low latency, others may need high throughput, therefore, the rules on nodes need update frequently. (low level requires)

Why UAV-sensor system need routing?

In some nature disaster scenarios, such as earthquake, It requires sensors to monitor xxx. After sensor deployed, sensor need to send data to it's nearest data station, the data stations often locate in somwhere relatively safe place, and it need keep monitoring the real-time data of

enevironment. But actually the data stations need to add or move according the condition of a disaster requirement, so the routing need update after these change occured.

The energy of UAV is limited, and the UAV number can not as much as sensor nodes, So UAVs can not always fly above sensor area, UAV fly above sensor area to update the network only when the base station changed or network function need to be update.

Software define wireless networking in UAV-enabled system

Why using UAV as control plane?

Mobility: UAV can fly to every part of network to configure nodes via wireless communication.

Multi-UAV to achieve **distributed** SDN.

Improving reliability, reduce hop number to reduce package lost, meanwhile, reducing latency.

Reducing energy consumption by reducing hop number.

More powerful computing platform on UAV (control plane).

Design

Route:

- UAV---UAV---nodes
- nodes---nodes---base sation

Trajectory:

- communication range-constraint
- energy-constraint

Neighbor discovery:

- UAV-UAV
- UAV-nodes

Flow table?

communication between UAVs

Applications

Routing algorithm; (software define)

Virtual sensor-----map

Multi-task

diagnosis

evaluator

AI XXX

Access Control; (access list)

Dynamic spectrum usage; (avoid interference, dependability, using some recognitive radio technology)

Monitor (monitor node power (route and deploy), node movement (route), analyze the reliability of data plane to dicide if we need to change routing or redeploy nodes)

Transmit power values control (energy)

Global time synchronization

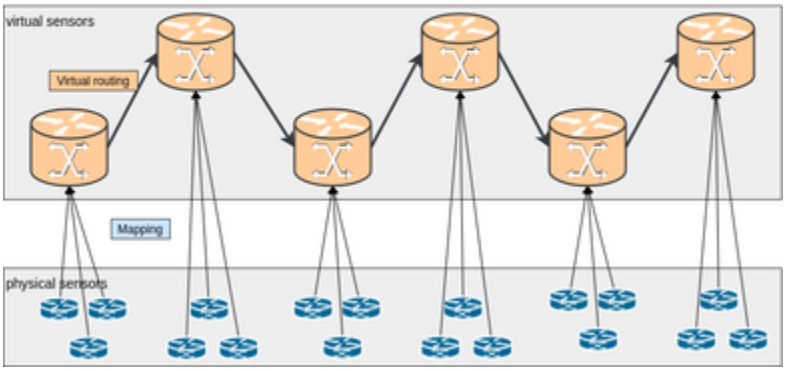
traffic engineering, mobility and wireless, measurement and monitoring, security and dependability and data center networking.

Design Novelty

- **The first distributed software define wireless sensor networking. A distributed controller can improve the control plane resilience and scalability and reduce the impact of problems caused by network partition (distributed and mobile).**
- **Considering energy balance routing algorithm base on global information. Energy efficiency;**
- **AI XXX Intelligence;**
- **Well defined interface for ease to use (flow table or APIs);**
- **Real implemation.**

Network virtualization

- multiple applications on one physical node (several application code on one, by update application code dynamically)
- one physical network used by several users, every user has different resource and permission, every user has a virtual network
- abstract virtual network by diverse applications, different application many using different nodes
- abstract several physical sensors to one virtual sensor
- some sensors is old and some sensor is new, how to make these two kind of sensor work togther?



Baseline

SDN-WISE: Design, prototyping and experimentation of a stateful SDN solution for WIreless SEnsor networks." *Computer Communications (INFOCOM), 2015 — Packet Delivery Ratio ---latency*

Energy minimization in multi-task software-defined sensor networks." IEEE transactions on computers 2015 ---multi-task energy—sensing rate, coverage ratio requirement

RPL(routing protocol for low power and lossy networks) is a IPv6 standards working under low-power and low-cost constraints rpl build routing need builiding overhead energy, throughput, routing repair time(routing fast repair)

Eavaluation

Eavaluation question: Reliability, Scalability, Energy, Rubustness

Eavaluation metrics:

END-END Packet Delivery Ratio vs. node number

throughput vs. node number

energy cost && lifetime vs. network size

routing rapair time (CDF) vs. RPL

routing rapair overhead vs. RPL

task number vs energy