

# Computer Networks Basic Protocols

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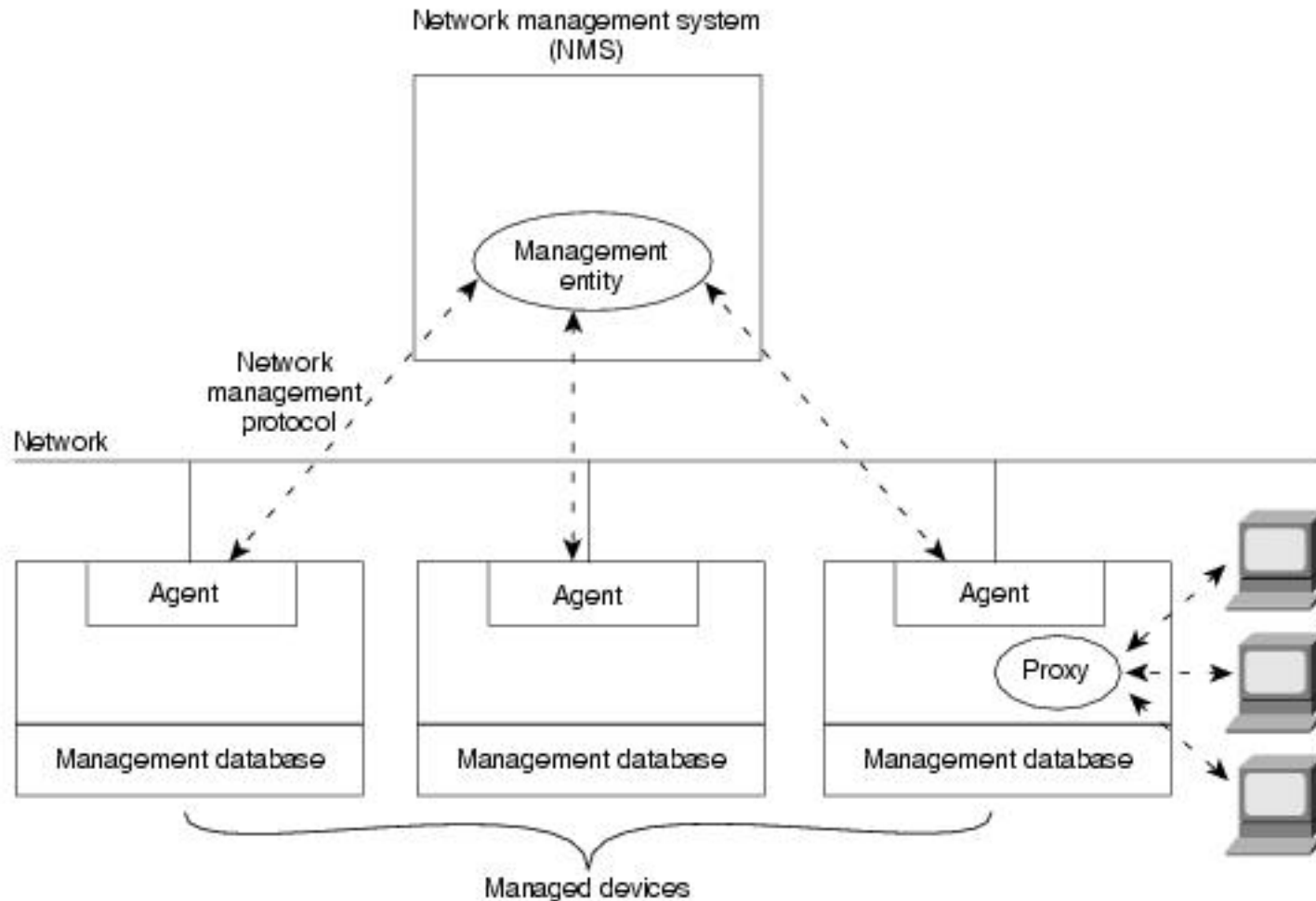
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**-Network Management-**

## References:

- Data and Computer Communications*, William Stallings, Pearson-Prentice Hall, 9<sup>th</sup> Edition, 2010.
- Computer Networking, A Top-Down Approach Featuring the Internet*, James F.Kurose, Keith W.Ross, Pearson-Addison Wesley, 6<sup>th</sup> Edition, 2012.

# Network Management Concept



# FCAPS..

- Fault Management
- Configuration Management
- Accounting Management
- Performance Management
- Security Management

# Fault Mngt

- Detection, isolation, and correction of abnormal operations
- Ensure that the network is always available and when a fault occurs, it can be fixed as rapidly as possible

# Configuration Mngt

- Initializing network
  - Provisioning the network resources and services
  - Monitoring and controlling the network
  - Setting, maintaining, adding, and updating the relationship among components and the status of the components during network operation
- 
- It can be performed either locally or remotely
  - Dynamic Host Configuration Protocol (DHCP) and Domain Name Services (DNS)

# Accounting Mngt

- Enables charge for the use of managed objects to be measured
- The resources consumed
- The facilities used to collect accounting data
- Set billing parameters for the services used by customers
- The maintenance of the databases used for billing purposes
- The preparation of resource usage
- Billing reports

# Performance Mngt

- Initializing a network
  - Provisioning the network resources and services
  - Monitoring and controlling the network
  - Setting, maintaining, adding, and updating the relationship among components and the status of the components during network operation
- 
- It can be performed either locally or remotely
  - Dynamic Host Configuration Protocol (DHCP)
  - Domain Name Services (DNS)

# Security Mngt

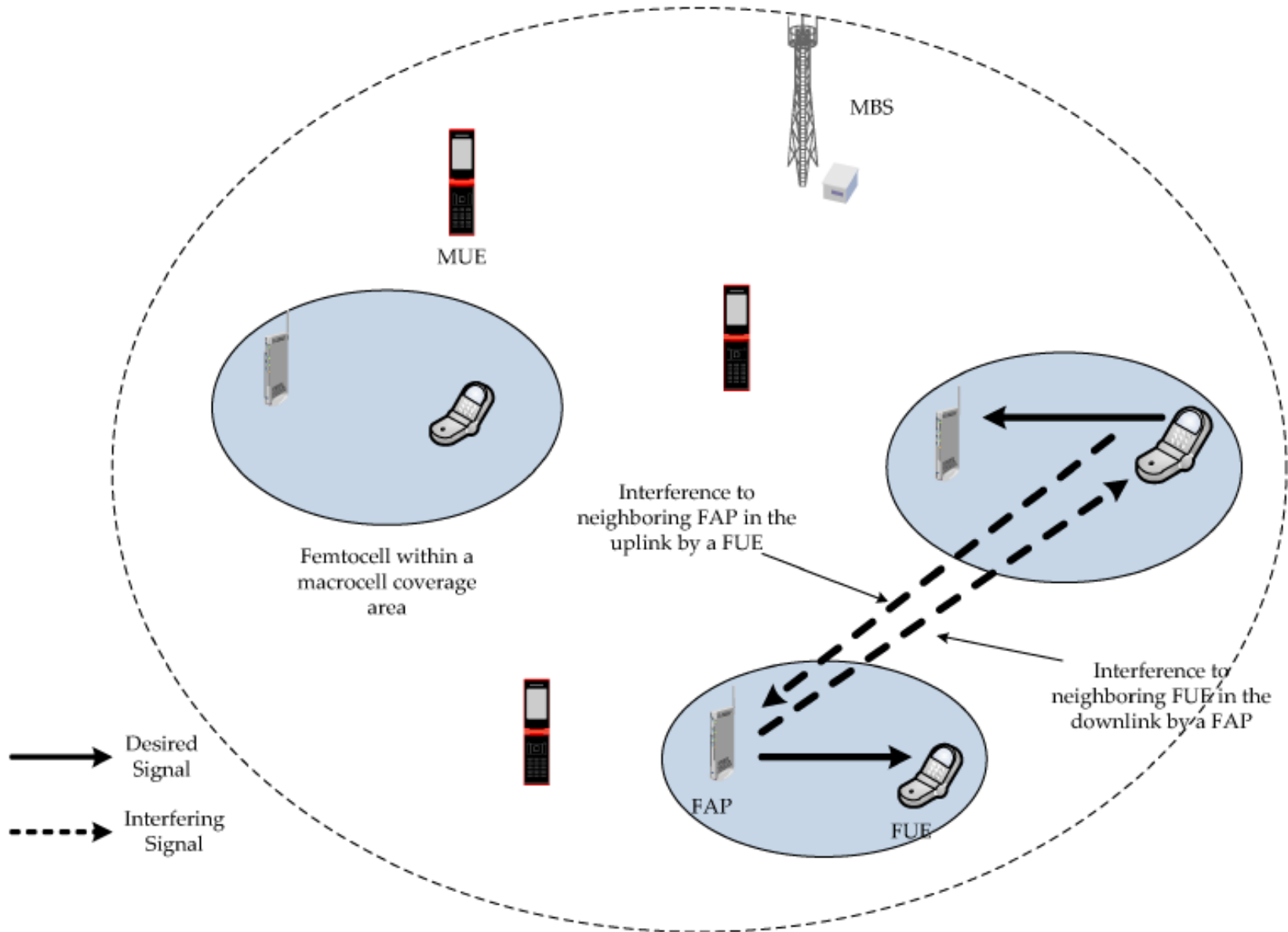
- Protects the networks and systems from unauthorized access and security attacks
- Authentication, encryption and authorization
- Generation, distribution, and storage of encryption keys as well as other security-related information
- Firewalls
- Real-time event monitoring
- Event logs



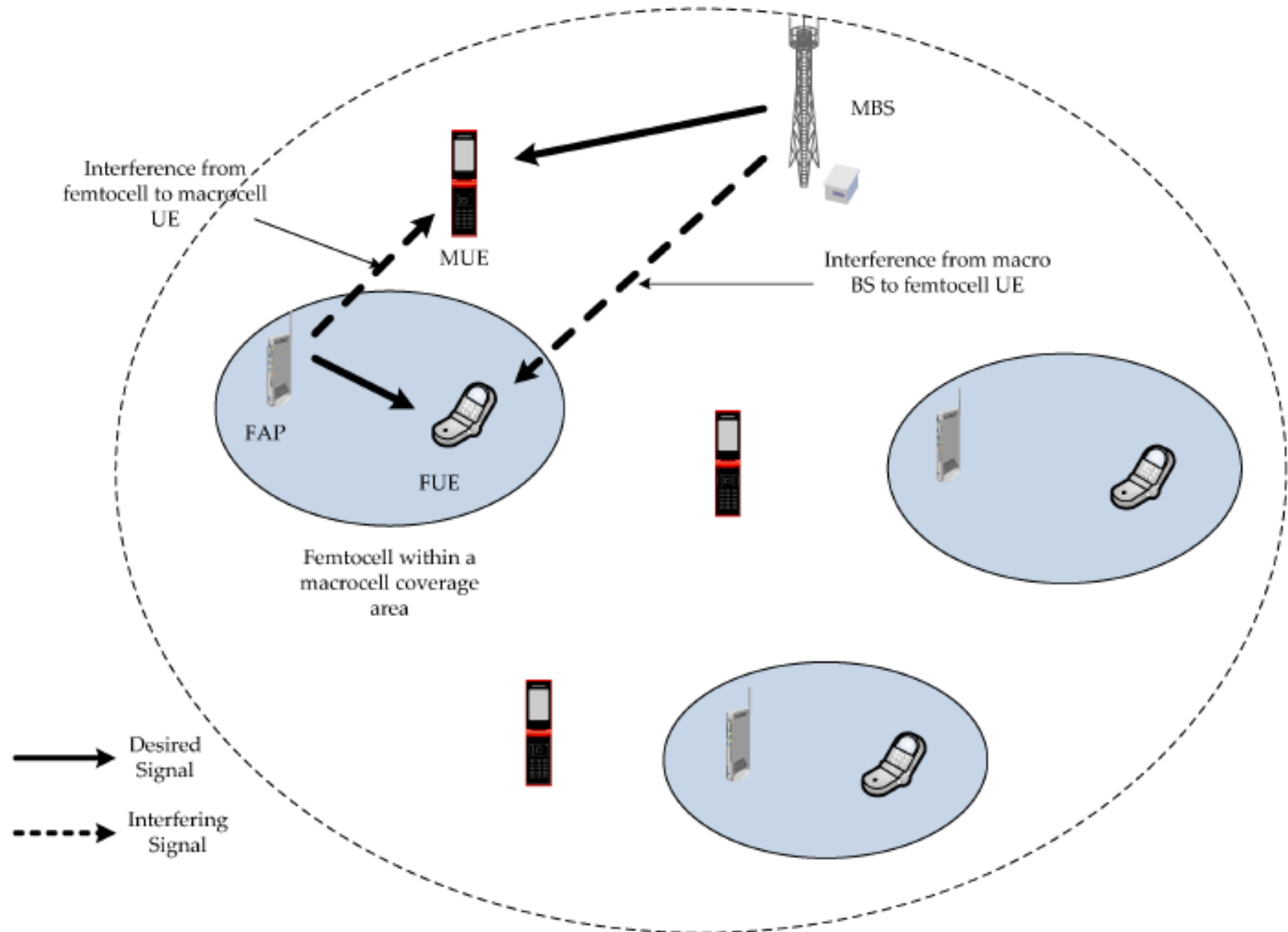
# Some “Wireless” Specific Management Concepts: Big Picture

- Interference Management
- Topology Management
- Location Management
- Power/Energy Management

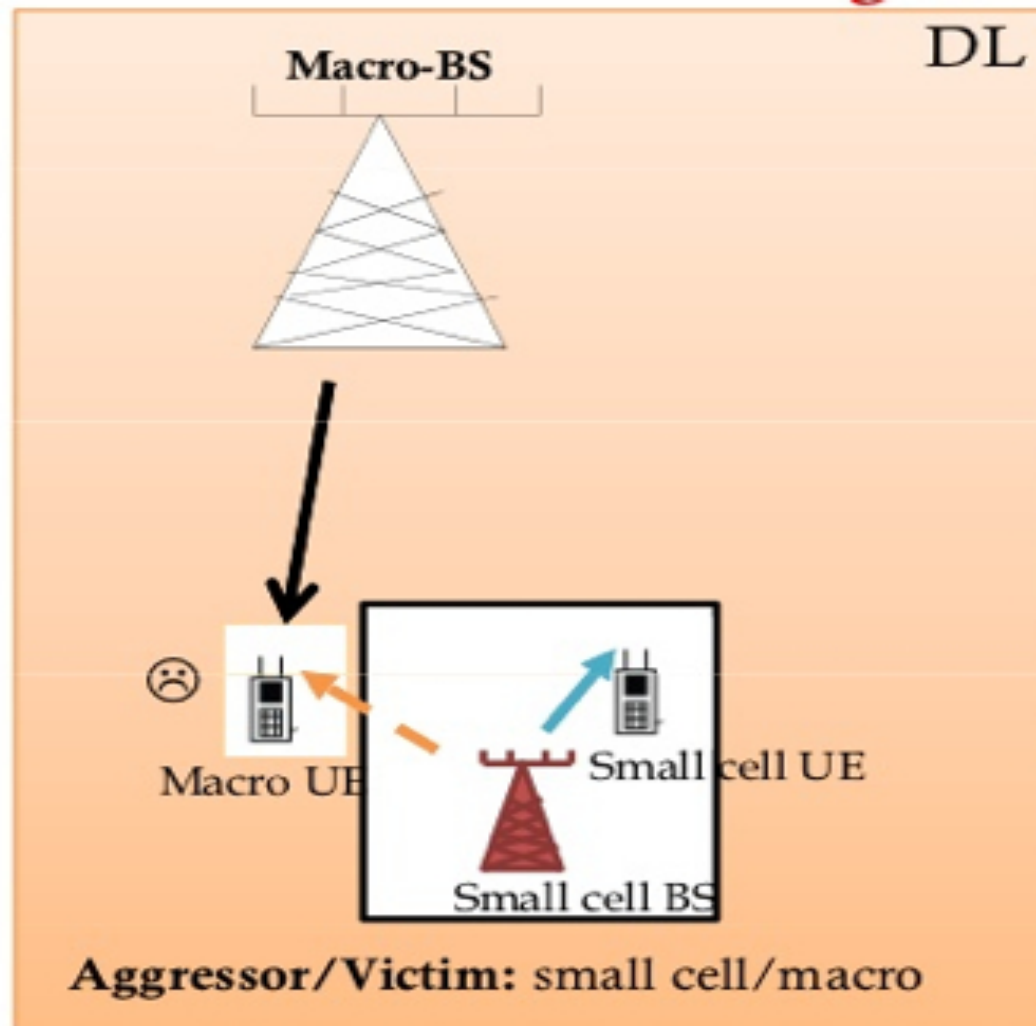
# An Example: Co-tier Interference



# Cross-tier (Xtier) Interference

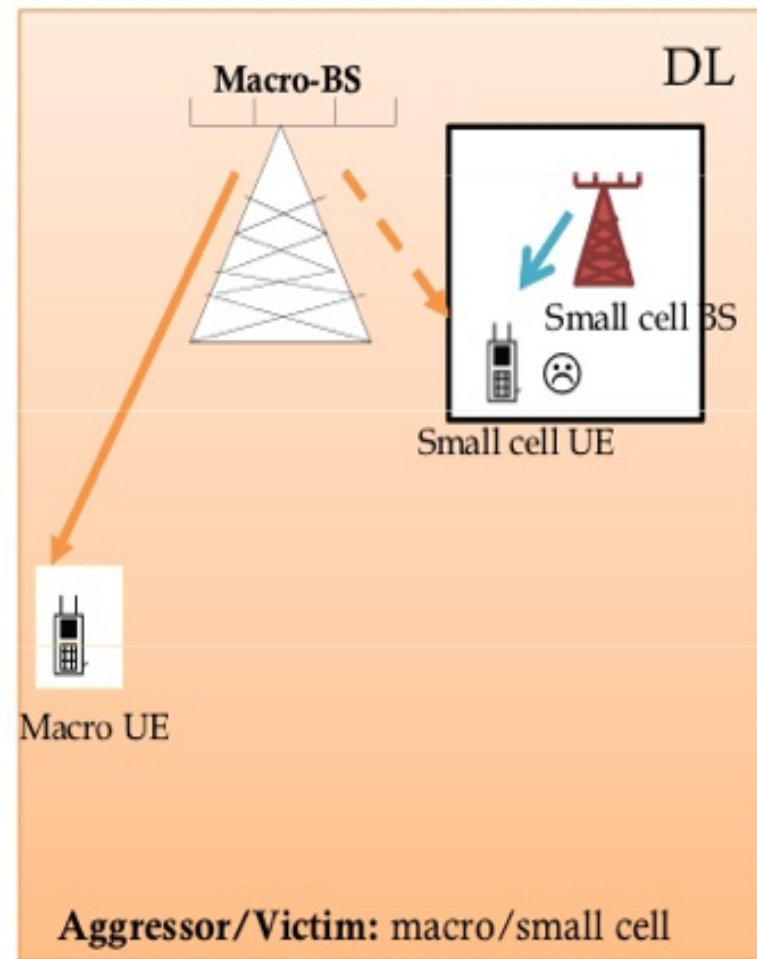


# Interference Management and Inter-Cell Interference Coordination

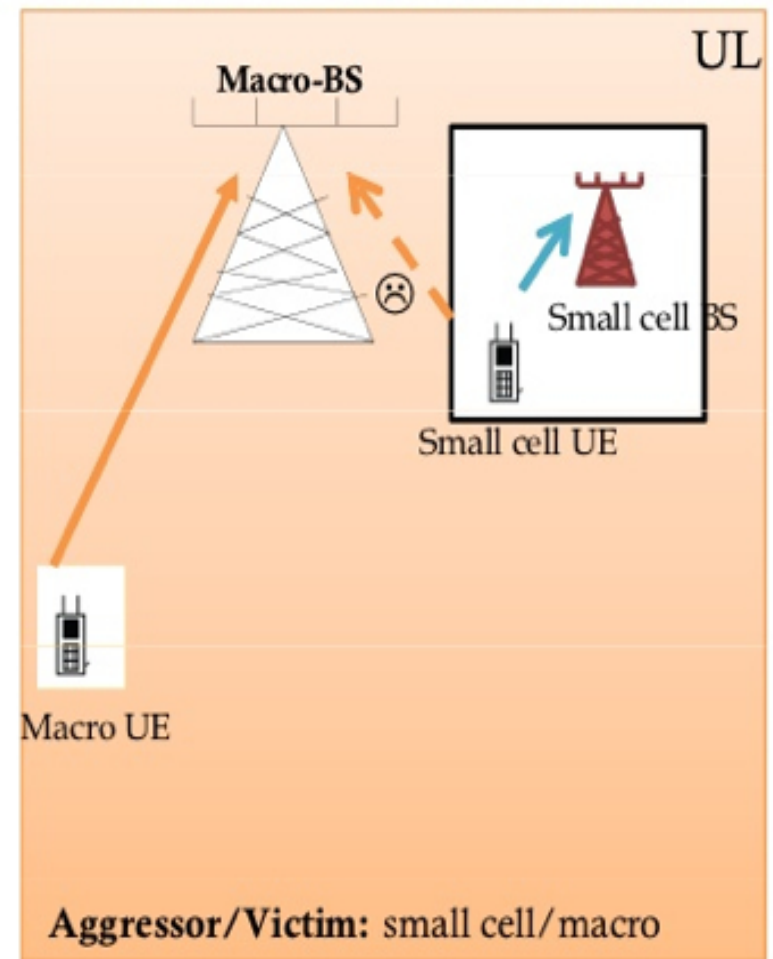


- DL interference from the small cell BS to nearby Macro UE
- A Macro UE far from its MBS will be affected the most

# Interference Management and Inter-Cell Interference Coordination

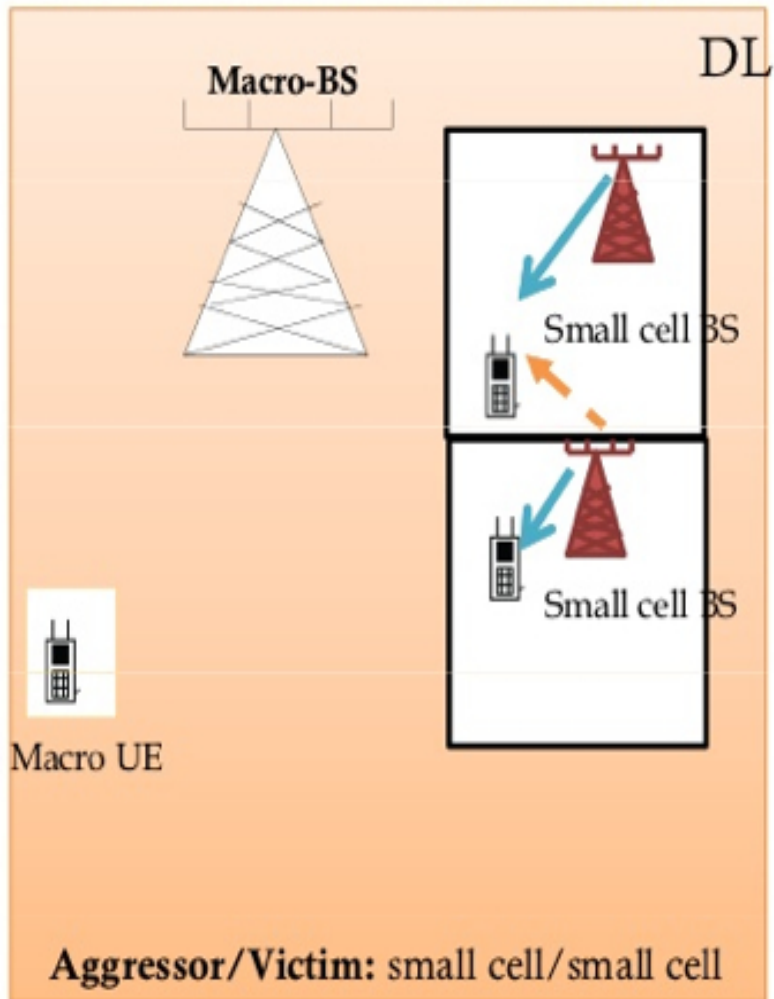


DL interference from nearby Macro-BS to small cell UE  
Interference from nearby Macro-BS can lower SINR of small cell UE

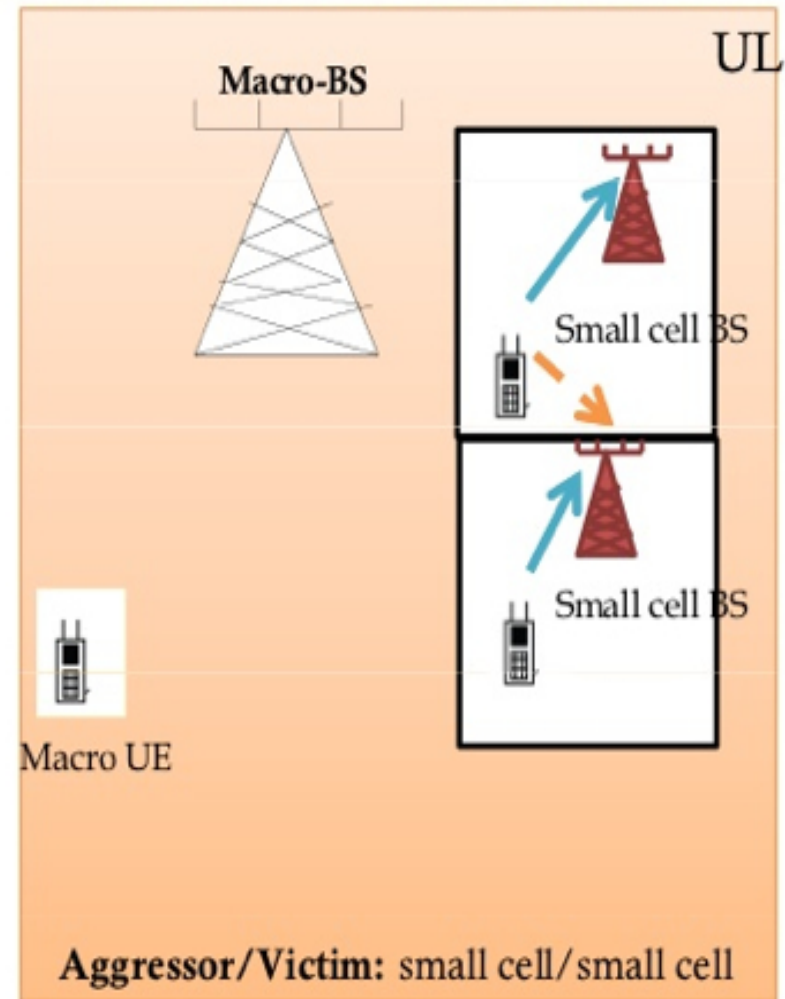


- UL interference from small cell UE to nearby Macro-BS
- Many active small cell UEs can cause severe interference to the Macro-BS

# Interference Management and Inter-Cell Interference Coordination



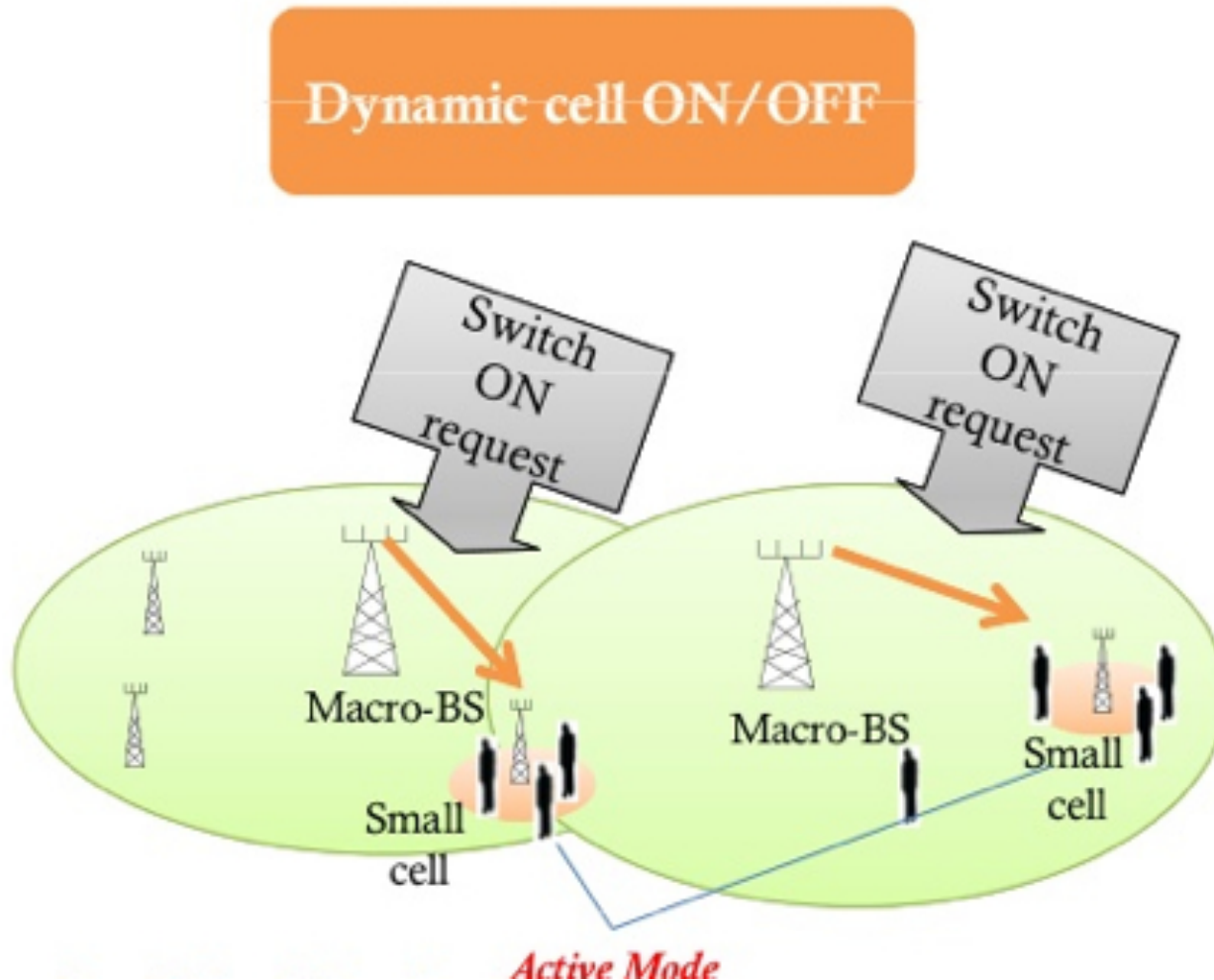
DL interference among nearby small cell networks

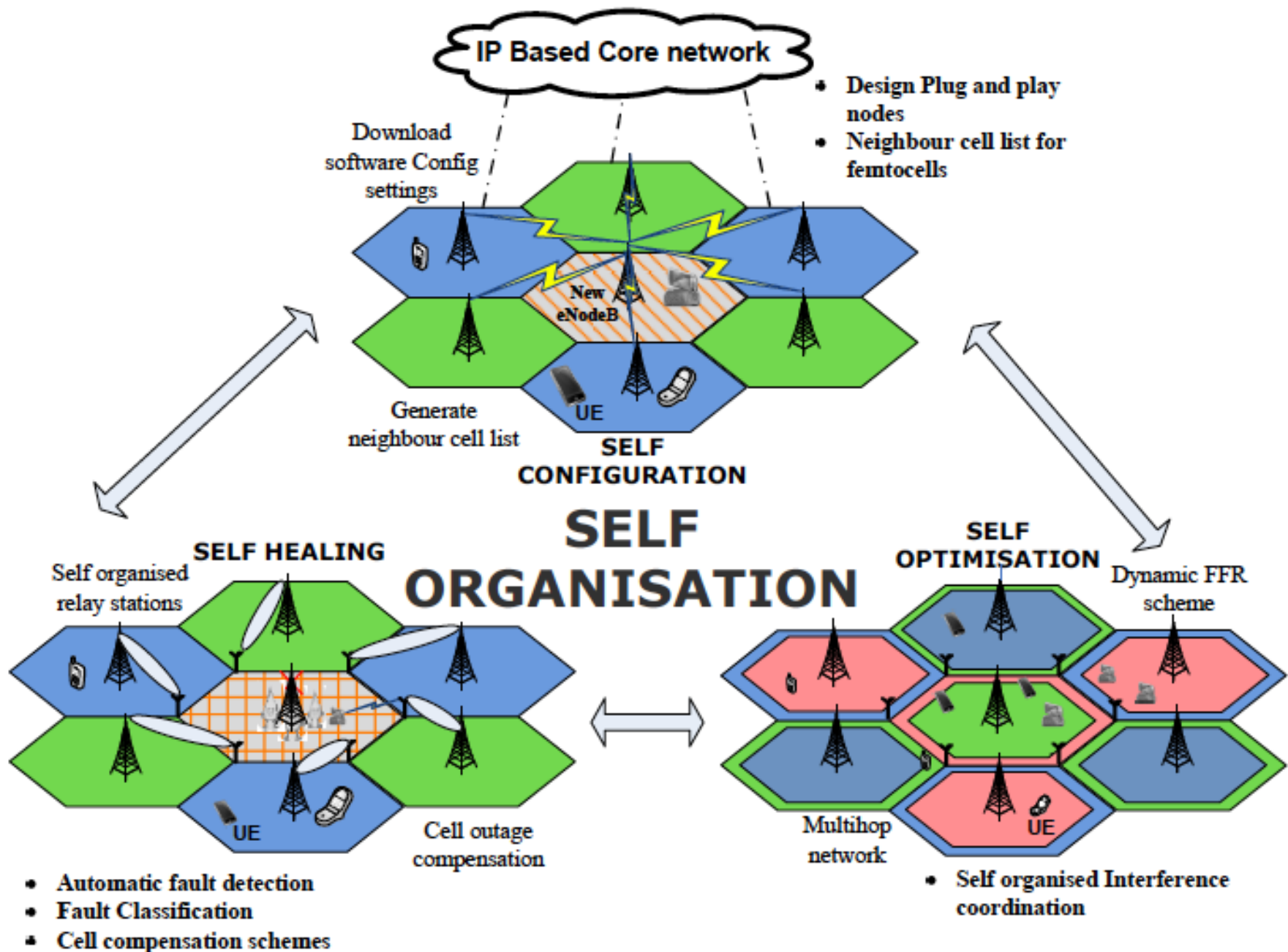


- UL interference among nearby small cell networks

# Energy Efficiency

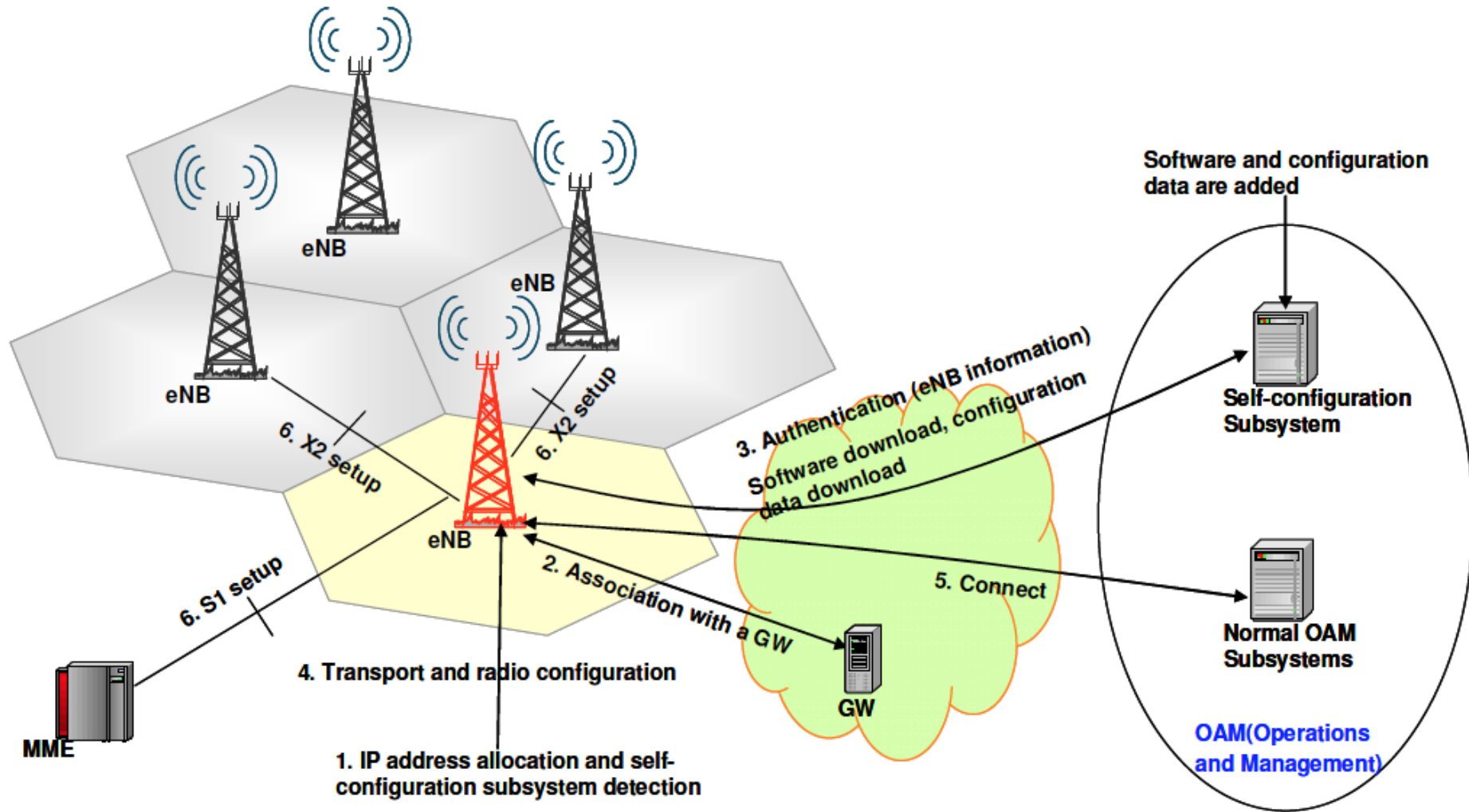
Dynamic switch ON/OFF for small cells







# LTE Network Management: Self Organizing Networks Concept



# Self-Organized Networking (SON)

## SON Use Cases

### Planning

NodeB Location

NodeB HW Configuration

NodeB Radio Parameter

Network Integration

NodeB Transport  
Parameter

aGW / OMC Parameter

### Deployment

HW Installation

Network Authentication

Software Installation

Transport Parameter  
Setup

Radio Parameter Setup

Testing

### Optimization

Radio Parameter  
Optimisation

Transport Parameter  
Optimisation

### Maintenance

Hardware Extension  
/Replacement

Software Upgrade

Network Monitoring

Failure Recovery

# Management → Planning

Use Case Examples	Short description
Planning location of a new eNodeB	Planning of location based on coverage and capacity goals. HW type and antenna type
Planning of radio parameters of a new eNodeB	Planning of power settings, neighbourhood list, and handover settings. Goal: to be substituted by self-configuration and self-optimisation.
Planning of transport parameter of a new eNodeB	Planning of transport parameters like addresses, Transport QoS settings etc. Goal: to be substituted by self-configuration and self-optimisation
Planning data alignment for all neighbour nodes	Including neighbourhood list retrieval of neighbour nodes and announcement of the new node to all neighbouring nodes including data base retrieval Goal: to be substituted by self-configuration and self-optimisation
Planning of a new Home eNB	Due to unclear concept of Home eNB the consequences of Home eNB on planning is ffs.

# SDN Architecture

## Applications Layer:

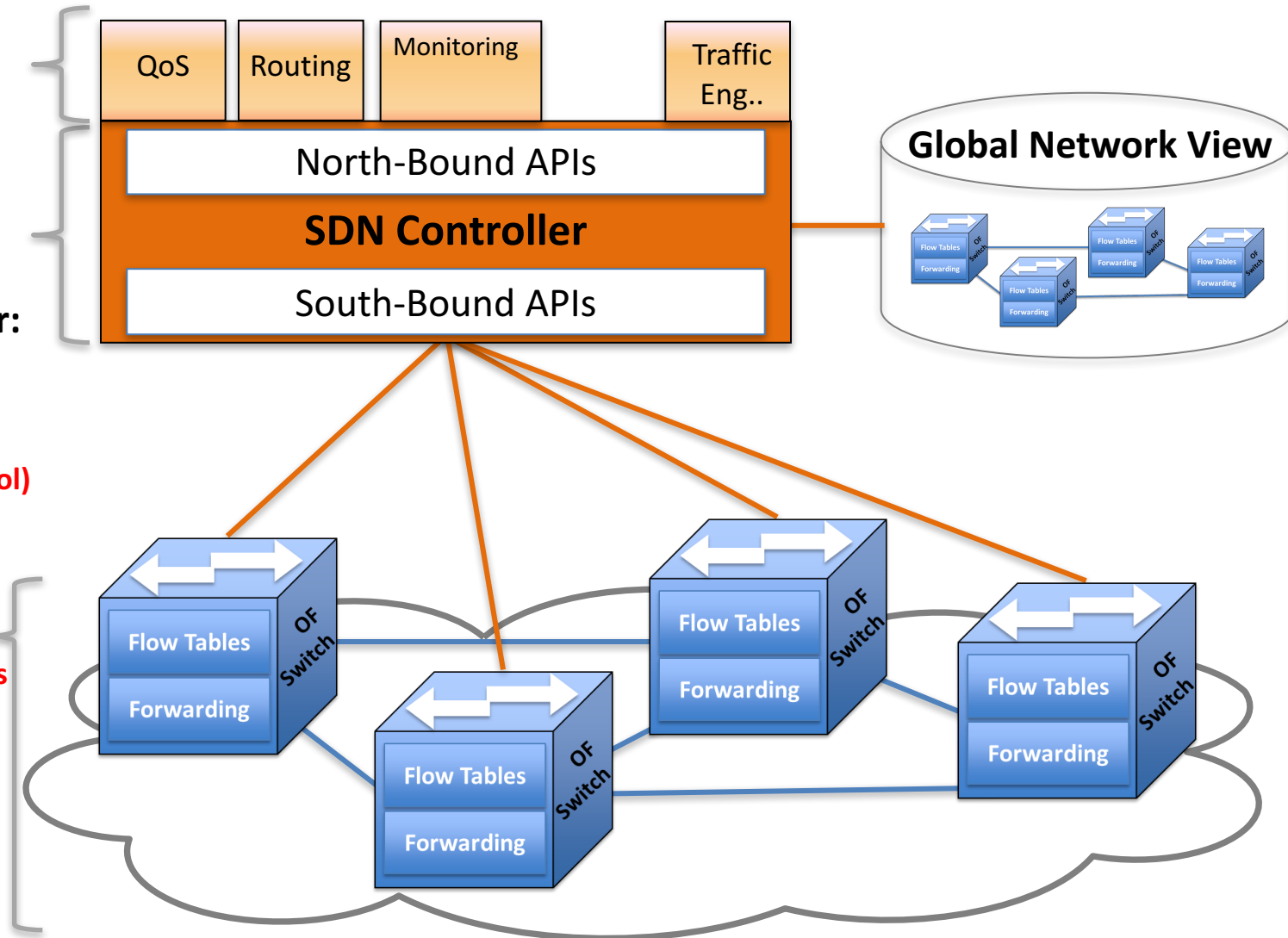
- SDN applications
- Business applications

## Control-Plane Layer:

- SDN Controller(s)
- North-bound APIs
- South-bound APIs (e.g., OpenFlow protocol)

## Data-Plane Layer:

- OpenFlow(OF) Switches
- Routers
- Other Infrastructure elements



# SDN Architecture

- **NW Controller (Control Plane)**
  - Global knowledge of the NW
  - Program and configure the forwarding tables in the OF switches by using new protocols, and algorithms
- **OpenFlow Switches or Software Defined Switches (Data Plane)**
  - Communicate with the SDN controller via the south-bound OF interface (e.g., OpenFlow protocol)
  - Multiple flow table pipelines exist for flow classifications

-Akyildiz, I. F. "5G Cellular Systems, A Look into to Next Decade", Georgia Institute of Technology, 2016.

-Akyildiz, I. F., Gutierrez-Estevez, D. M., Balakrishnan, R., Chavarria-Reyes, E., "LTE-Advanced and the Evolution to Beyond 4G (B4G) Systems," Physical Communication (Elsevier) Journal, vol. 10, pp. 31-60, March 2014.

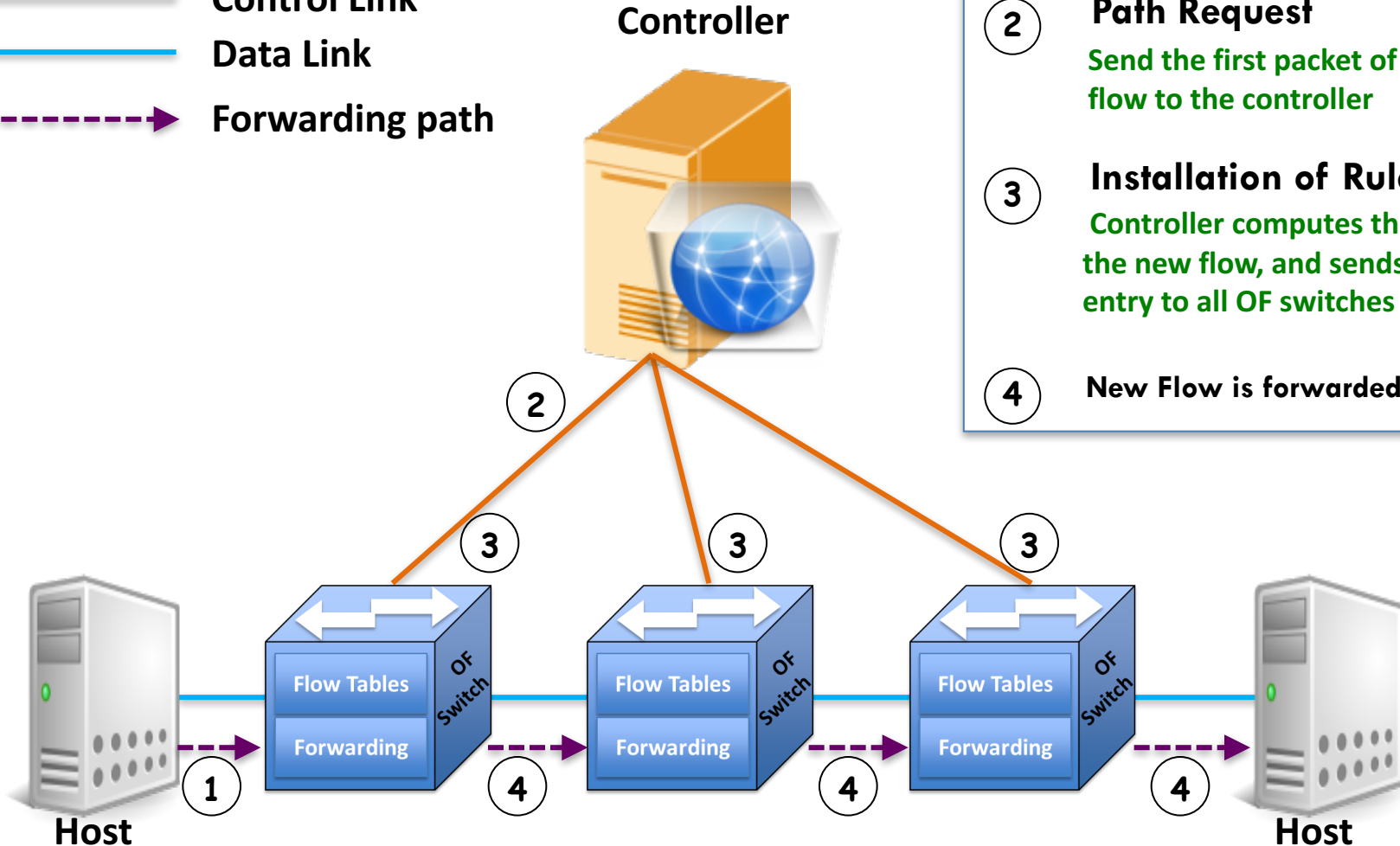
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-I. F. Akyildiz, P. Wang, and S. C. Lin, "SoftAir: A Software Defined Networking Architecture for 5G Wireless Systems" to appear in Computer Networks (Elsevier) Journal, 2015.

-I. F. Akyildiz, P. Wang, and S. C. Lin, "A Qualitative Evaluation of Existing W-SDN-NFV and C-RAN Solutions" to appear in Computer Networks (Elsevier) Journal, 2015.

# SDN Operation

— Control Link  
— Data Link  
- - - Forwarding path



## Example of Flow Management

- 1 New Flow Arrival**  
If the new flow does not match the flow entries at the Flow Tables
- 2 Path Request**  
Send the first packet of the new flow to the controller
- 3 Installation of Rules**  
Controller computes the path for the new flow, and sends the flow entry to all OF switches
- 4 New Flow is forwarded to destination**