LTE Signaling for IoT

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System Engineer

Outlines

- Introduction.
- current signaling solutions.
- Increasing the efficiency of current signaling solutions.
- Capacity planning for profusion of smart connected devices.
- Planning for advanced “signaling storm handling” in IoT infrastructure .
- Conclusion.

Introduction

- Cellular connectivity is reaching beyond smartphones and tablets, providing access to data networks for connected home appliances, machinery and vehicles.
- The ongoing evolution of wireless cellular networks is creating a new ecosystem with pervasive presence of a great variety of network-enabled objects which, based on unique addressing schemes, are able to interact with each other.
- The rapid evolution of mobile networking technologies and the transition towards IPv6 might drive this trend to an ecosystem where every single consumer item could be reachable through the cellular network .
- This convergence of the Internet and cellular mobility networks is breeding new Machine-to-Machine (M2M) communication systems, which are the enabling platform for the Internet of Things (IoT).
- ***"Internet of Things"*** is a phrase to describe a system where the Internet is connected to the physical world via ubiquitous sensors.

Consumer & Home

Smart Infrastructure

Security & Surveillance

Healthcare

Network

Transportation

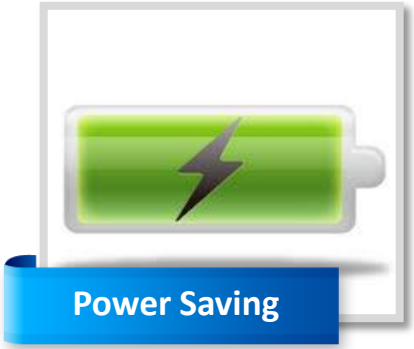
Retail

Industrial

Others

As the “Internet of Things” becomes more prevalent, communications capabilities will be extended to billions of objects making signaling traffic a potential bottleneck.

Making The Network Ready For The Internet of Thing



IoT Challenges

- Introduction.

• CURRENT SIGNALING SOLUTIONS.

- Increasing the efficiency of current signaling solutions.
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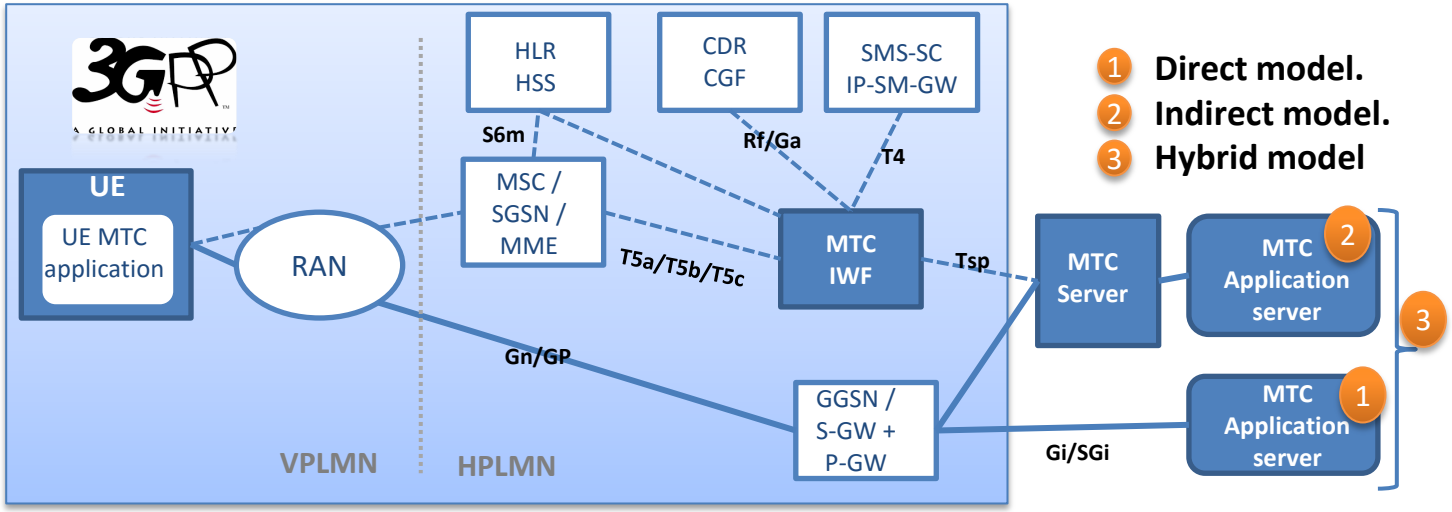
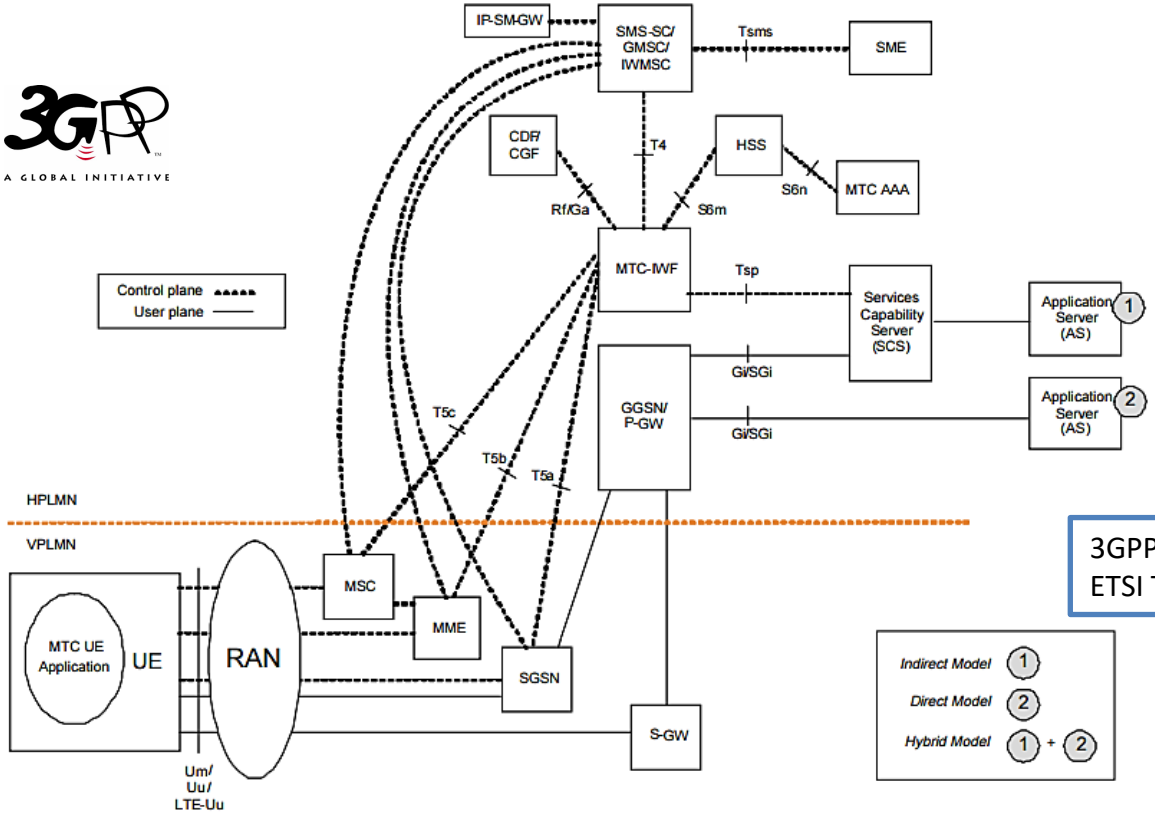
3GPP machine type communication (MTC)enhancement -architecture



UE	User Equipment
IWF	Interworking Function
CDR/ CGF	Charging Data Record / Charging Gateway Function
HLR /HSS	Home Location Register /Home Subscriber Server
RAN	Radio Access Network
MCS / SGSN / MME	modulation and coding scheme/ Serving GPRS Support Node/ Mobility Management Entity
SMS-SC IP-SM-GW	Short Message Service - Service Center / IP-Short-Message-Gateway
GGSN /S-GW /P-GW	The Gateway GPRS Support Node / Serving Gateway /Packet Data Network Gateway

S6m : HSS – MTC diameter interface .	Rf/Ga: diameter credit control interface(Rating Function)/GPRS interface.
T5a/T5b/T5c /Tsp : MTC related reference points	T4::diameter interface for communication between PDN and Application.
Gn/GP : GPRS interfaces .	Gi / SGi : PGW to external PDN (Packet Data network) Gateway
PLMN/VPLMN :Public Land Mobile Network / Visited PLMN	

3GPP Architecture for Machine-Type Communication



3GPP TS 23.682 version 11.2.0 Release 11
ETSI TS 123 682 V11.2.0 (2012-11)

IoT Startups Companies

The Internet of Things movement relies on the innovation of IoT startups. Here are 10 companies ready to become household names in the world of IoT:

1. **BLiNQ Networks**
2. **Davra Networks**
3. **Electric Imp**
4. **Estimote**
5. **Evrythng**
6. **Helium**
7. **IFTTT**
8. **Libelium**
9. **Samsara**
10. **Sigfox**

Sigfox :

A French networking company whose technology is already supporting large Internet of Things (IoT) deployments in several countries in Europe, has its sights set on the U.S. market also in Omantel.

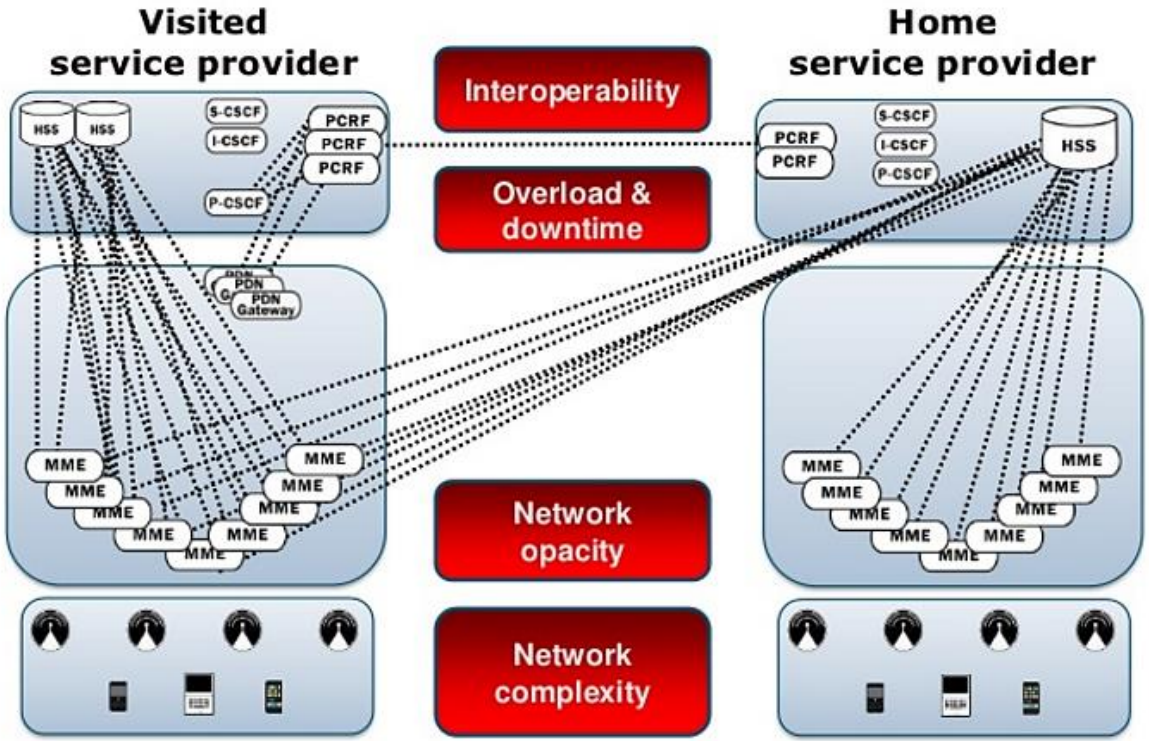
Sigfox

- Sigfox deploys Low-Power Wide Area Networks (LPWAN) that work in concert with hardware that manufacturers can integrate into their products.
- The network takes a similar approach to traditional GSM networks for compatibility.
- Any device with integrated Sigfox hardware can connect to the internet – in regions where a Sigfox network has been deployed – without any external hardware, like a Wi-Fi or Zigbee router.
- But, in another sense, the Sigfox network is entirely different than traditional GSM networks, in that it can only transmit small amounts of data, at just 100 bits per second.
- The Sigfox system uses silicon such as the EZRadioPro wireless transceivers from Silicon Labs, which deliver industry-leading wireless performance, extended range and ultra-low power consumption for wireless networking applications operating in the sub-1GHz band.

IoT Deployment Challenges

- Complicity ,Integration.
- Sharing revenue in joint ecosystem.
- The challenge of deploying an innovative solution in a production IT environment leading long time to market.

Diameter Signaling Pain Points



- Introduction.
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• INCREASING THE EFFICIENCY OF CURRENT SIGNALING SOLUTIONS

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DRA and DEA

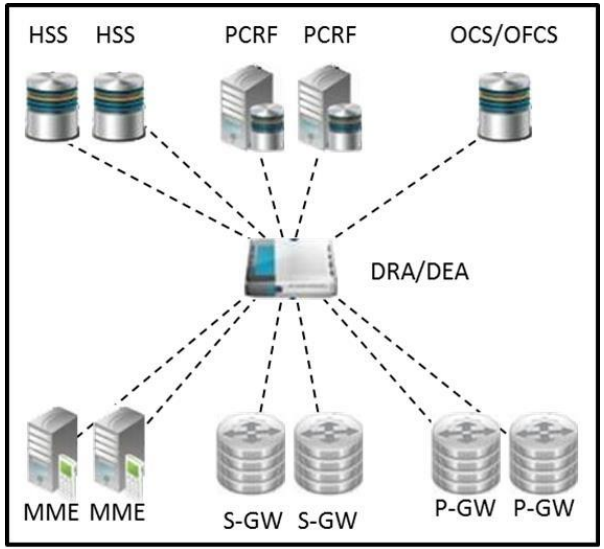
- **Diameter Routing Agent (DRA):**

Is the network component to secure and centralize Diameter communication with other roaming partners and to increase the operation efficiency and reliability of the internal Diameter signaling Network.

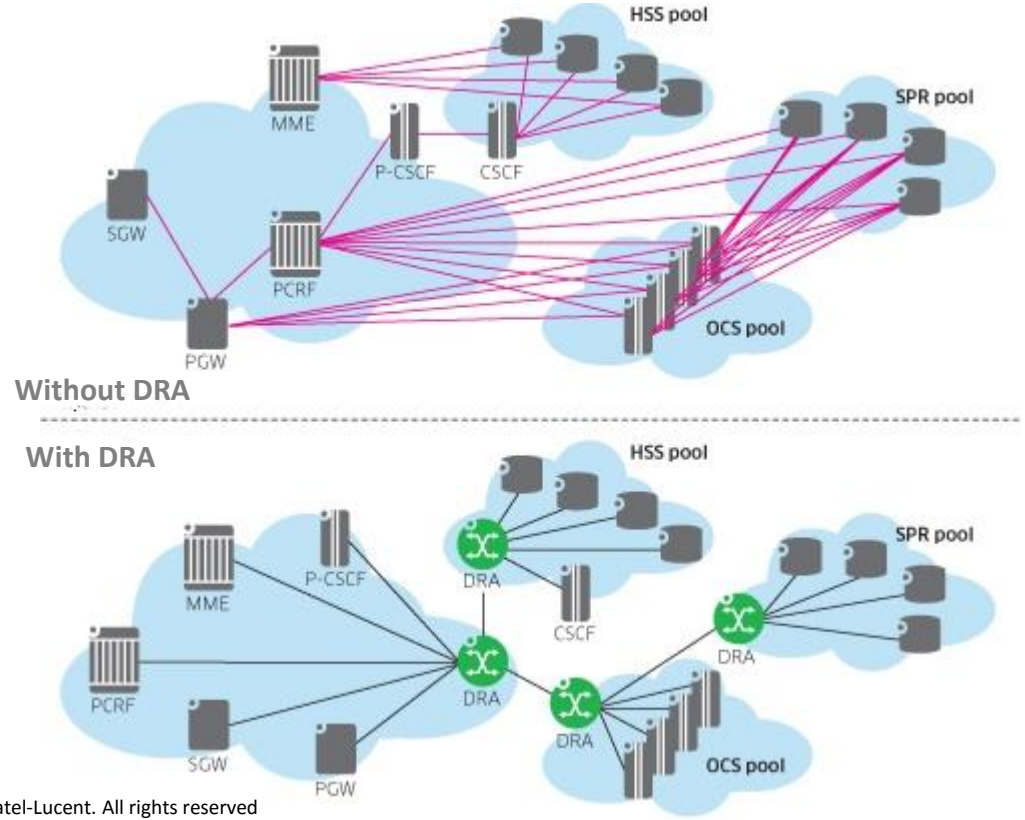
- **Diameter Edge Agent (DEA):**

LTE Roaming through the Diameter Edge Agent (DEA) provides:

- Topology hiding
- Roaming relations
- Message screening
- Diameter transit traffic management
- Diameter traffic policing
- Diameter accounting and statistics
- Diameter traffic shaping



DRAs Simplify the Diameter Control Topology

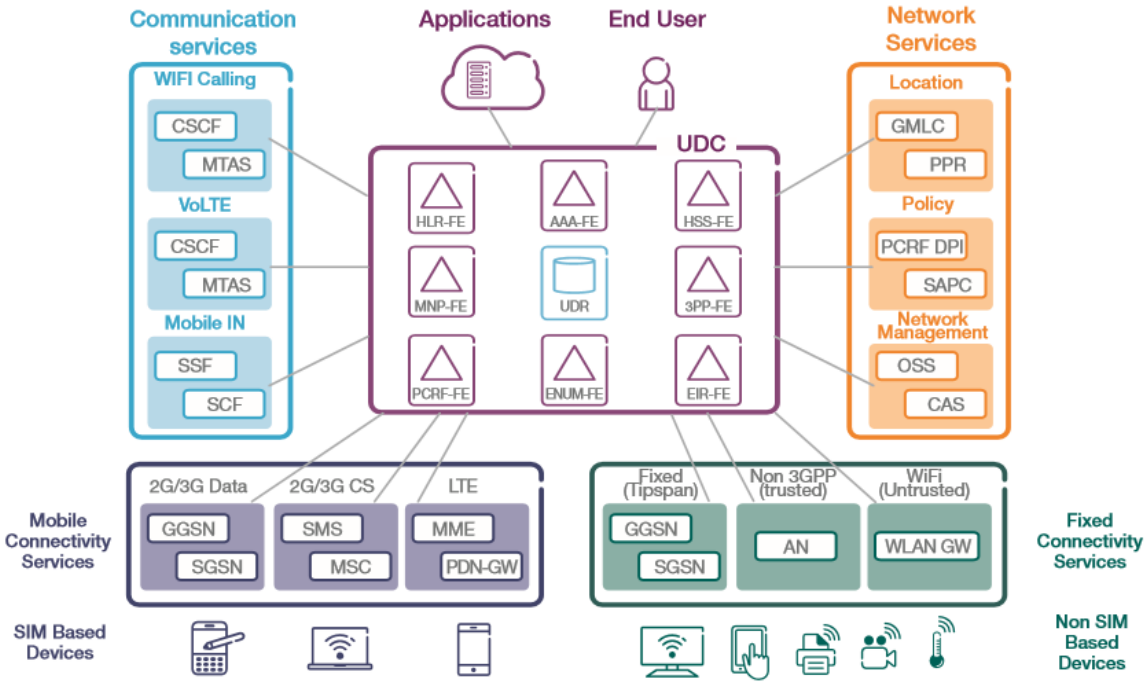


Ericson User Data Management system

Enables :

- ✓ Data consolidation.
- ✓ Simplification of the network design.
- ✓ The provisioning flows. and maintenance.

CAPEX and OPEX Savings.

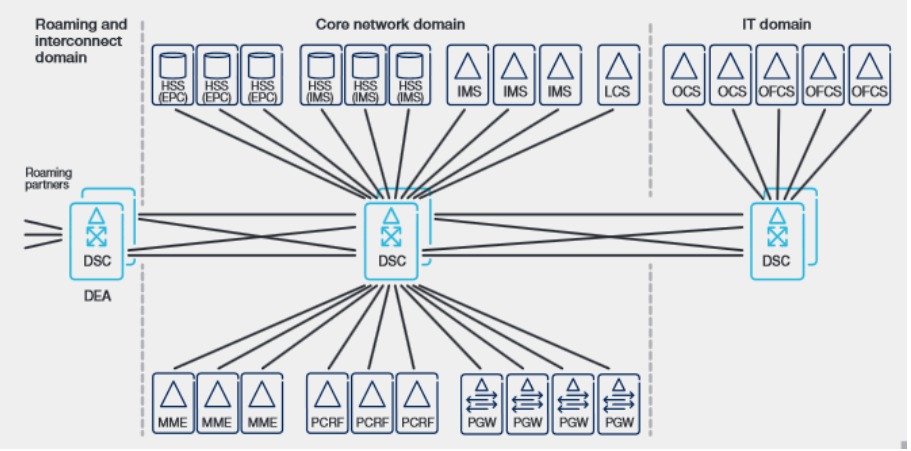


Ericson UDC in the network

Diameter Signaling Controllers

Using a **Diameter signaling solutions** that consolidates and centralizes signaling routing, load balancing, interworking, connectivity, health monitoring and security together .

- DSC is the key to enable Clouding at the existing network infrastructure.



DCS Diameter Signaling Controllers

DSC Tools

DSC gives tools to address security concerns and handle signaling storms, including:

- **Diameter Routing Agent (DRA)**

  For failover and policy-based routing.

- **Diameter Edge Agent (DEA)**

  To secure roaming and inter-network connections.

- **Diameter load balancer**

  To protect against overload conditions and service degradation.

- **Diameter gateway**

  That provides multi-protocol translation ,mediation .

DSC Meets the LTE IoT Signaling Challenges

- **Element Connectivity**

  Designing a scalable network architecture

- **Message Normalization**

  Deal with different vendors' Diameter implementations.

- **Load Balancing**

  Protect against signaling spikes ,signaling storm.

- **Routing and Subscriber Guidance**

  Implement network wide session binding.

- **Roaming for LTE**

  Manage LTE Roaming with LTE and 2G, 3G, Wi-Fi internetworking .

- **Topology Hiding**

  Hide network topology.

- **Visibility into Diameter Control Plane**

  View what's going on and how to test.

Improve Network Performance

Signaling can be tweaked to improve network performance,

as following :

- Data control messages can be delayed, queued and then transmitted in batches.
- Repeated data can be identified and piggybacked to prevent the need to create and tear down multiple messaging sessions.
- Signaling messages can be balanced over time to prevent bursts.

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NB IoT

NB IoT : is a radio-access network that minimizes battery usage, covers a wide area, and functions with simplified low-cost devices while efficiently matching the varying spectrum allocations of operators.

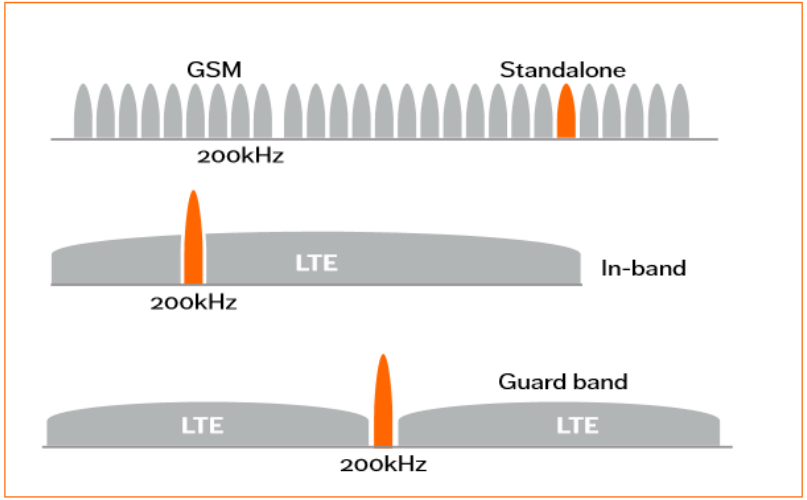
- ✓ 3GPP release 13 specifications includes the NB-IoT feature, with a large degree of deployment flexibility to maximize migration possibilities and allow the technology to be deployed in GSM spectrum, in an LTE carrier, or in a WCDMA or LTE guard band.
- ✓ **NB-LTE technology** allows a high re-use of already existing LTE network technology for both infrastructure and chipset. This will favor a fast adoption and maximize economies of scale.

NB IoT

The technology can be deployed :

1. **“in-band”** utilizing resource blocks within a normal LTE carrier.
2. “**guard-band”** in the unused resource blocks within a LTE carrier’s.
3. **“standalone**” for deployments in dedicated spectrum.

NB-IoT is also particularly suitable for the re-farming of GSM channels.



Spectrum usage deployment options

NB IoT technology will provide:

- ✓ Improved indoor coverage.
- ✓ Support for a massive number of low throughput devices.
- ✓ Low delay sensitivity.
- ✓ Ultra-low device cost.
- ✓ Low device power consumption.
- ✓ Optimized network architecture.

Cloud

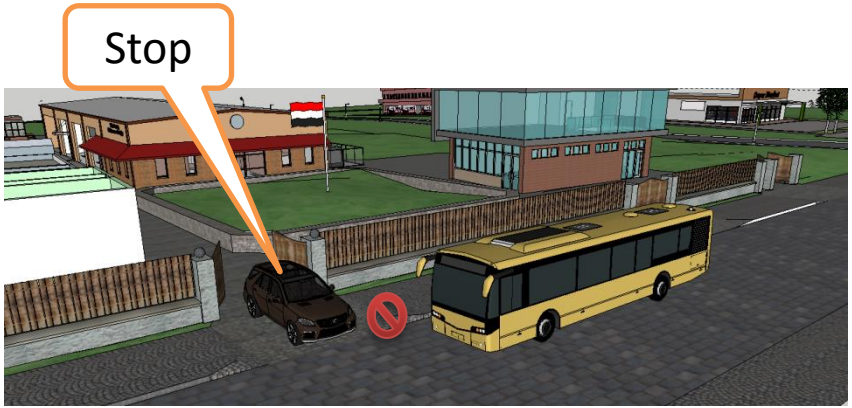
- Cloud Storage.
- Mobile backend as a Service (MBaaS).
- Cloud Software as a Service (SaaS).
- Cloud Platform as a Service (PaaS).
- Security as a Service(SECaaS).
- Cloud Infrastructure as a Service (IaaS).
- ….

Reduce Latency and Increase Security Level

- IoT has additional security requirements from the mobile network, due to the different nature of the Endpoint devices and the potential high level of service criticality. While serving a large number of Endpoint devices.

- Different industries use many different types of connections for IoT devices, such as serial, Bluetooth, ZigBee, and Z-Wave.

- Delays in data transmission can be life-threatening if the sensors are part of a vehicle-to-vehicle communication system or large-scale distributed control system for rail travel.



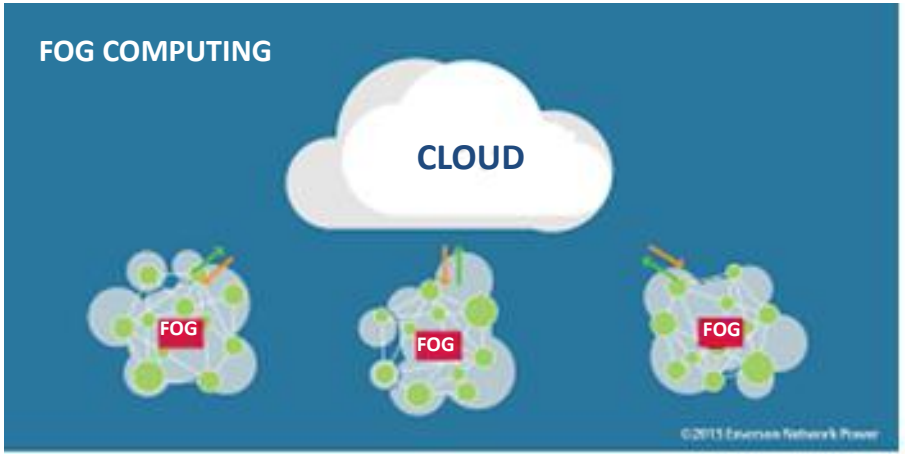
Fog Computing (Fog Networking)

- Decentralized computing infrastructure in which computing resources and application services are distributed in the most logical, efficient place at any point along the continuum from the data source to the cloud.

“Fog Computing "
Conveying the idea that the advantages of cloud computing should be brought closer to the data source.

Fog networking Goals :

- ✓ Improve efficiency.
- ✓ Reduce the amount of data that needs to be transported to the cloud for data processing, analysis and storage.
- ✓ Security and compliance reasons.



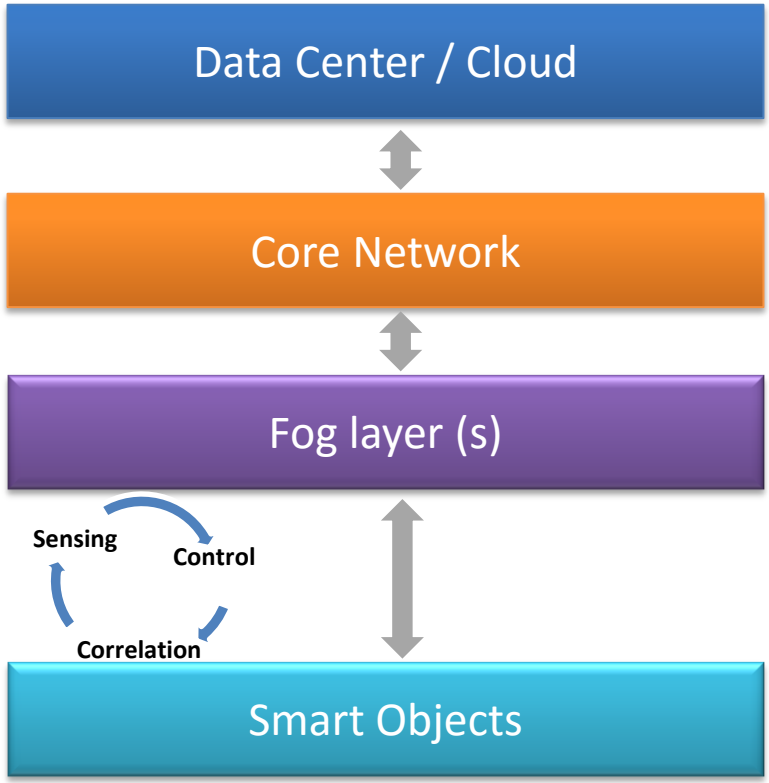
IoT with Fog Computing

Data Center / Cloud
Hosting IoT Analytics.

Backhaul
IP/MPLS , Security ,QoS ,Multicast.

Multi-Service Edge
Local IoT Analytics, Storage …

Embedded System & Sensors
Low power ,low bandwidth.



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.

- Conclusion.

Signaling Storm

Telecom operators are experiencing signaling storms in two fronts:

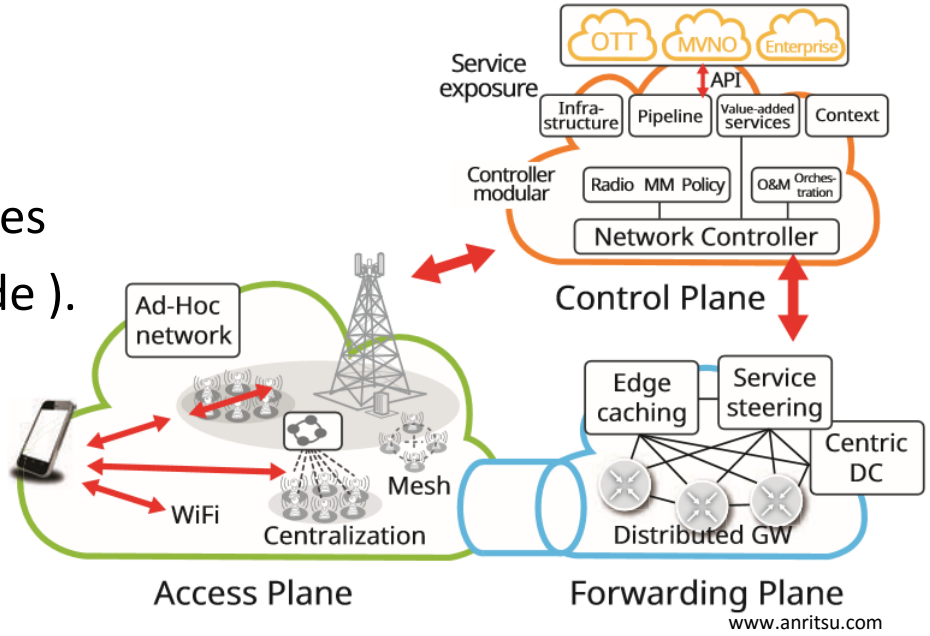
- the radio access network (RAN) and the MAP.
- and Diameter signaling traffic in the core network (CN).

- The continuous modernization of operator's networks.
- The increasing centralization of resources in higher capacity systems, such as Data Layered architectures in the user data management space.

leading to networks being more exposed to **signaling storms**

Advanced Signaling Storm Handling

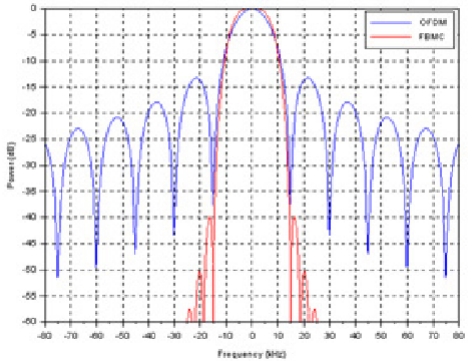
- Multi planes based architecture (SDN ,NFV ,cloud).
- Smarter network elements or nodes (SC Signaling controllers in each node).
- Addressing(IPv6).
- Design applications with awareness about mobile network signaling efficiency principles.



Three-planes based 5G network architecture

New RAN Functionalities in 5G

New Waveform

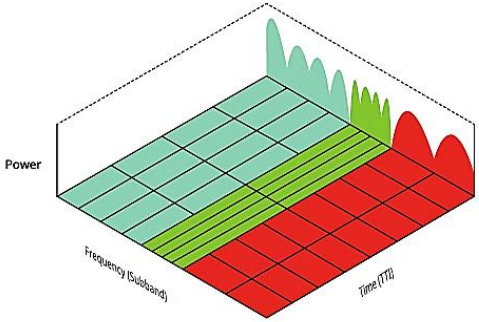


Spectrum of Shaping Pulses for OFDM and FBMC

new numerology

is a method allowing variable TTI (Transmission Time Interval) When new numerology and FBMC (Filter Bank Multiple Carrier transmission scheme)are combined.

A band can be composed of sub-bands with different TTIs as shown in Figure. Here, three group of sub-bands with TTI of {0.5 ms (red), 2 ms (green), 1 ms (cyan) }are combined into a band where the first, second and third group consists of 2, 4 and 4 sub-bands.



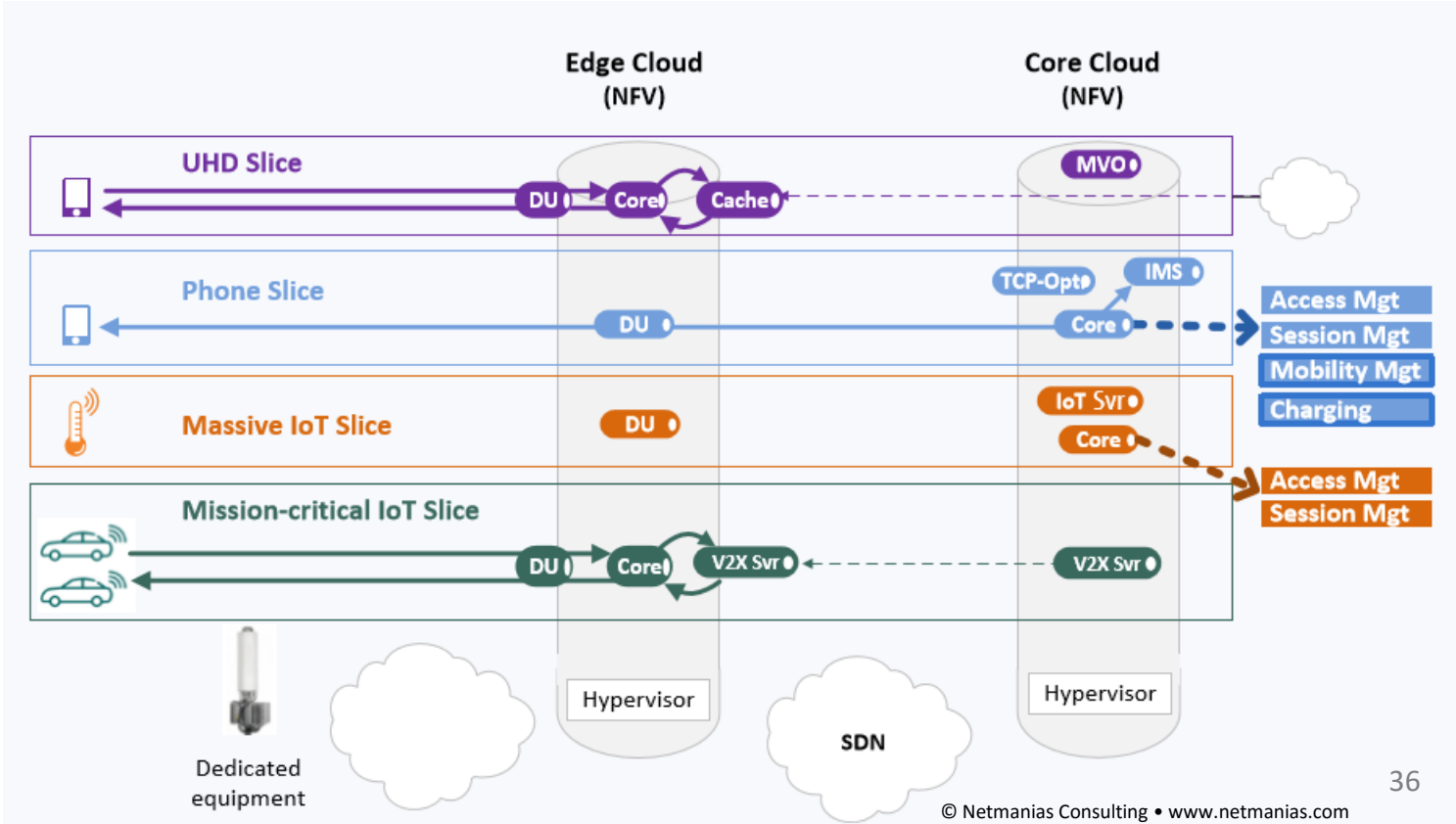
Combination of Sub-bands with Different TTIs

ULTRA-HIGH RADIO SPEED ⇒

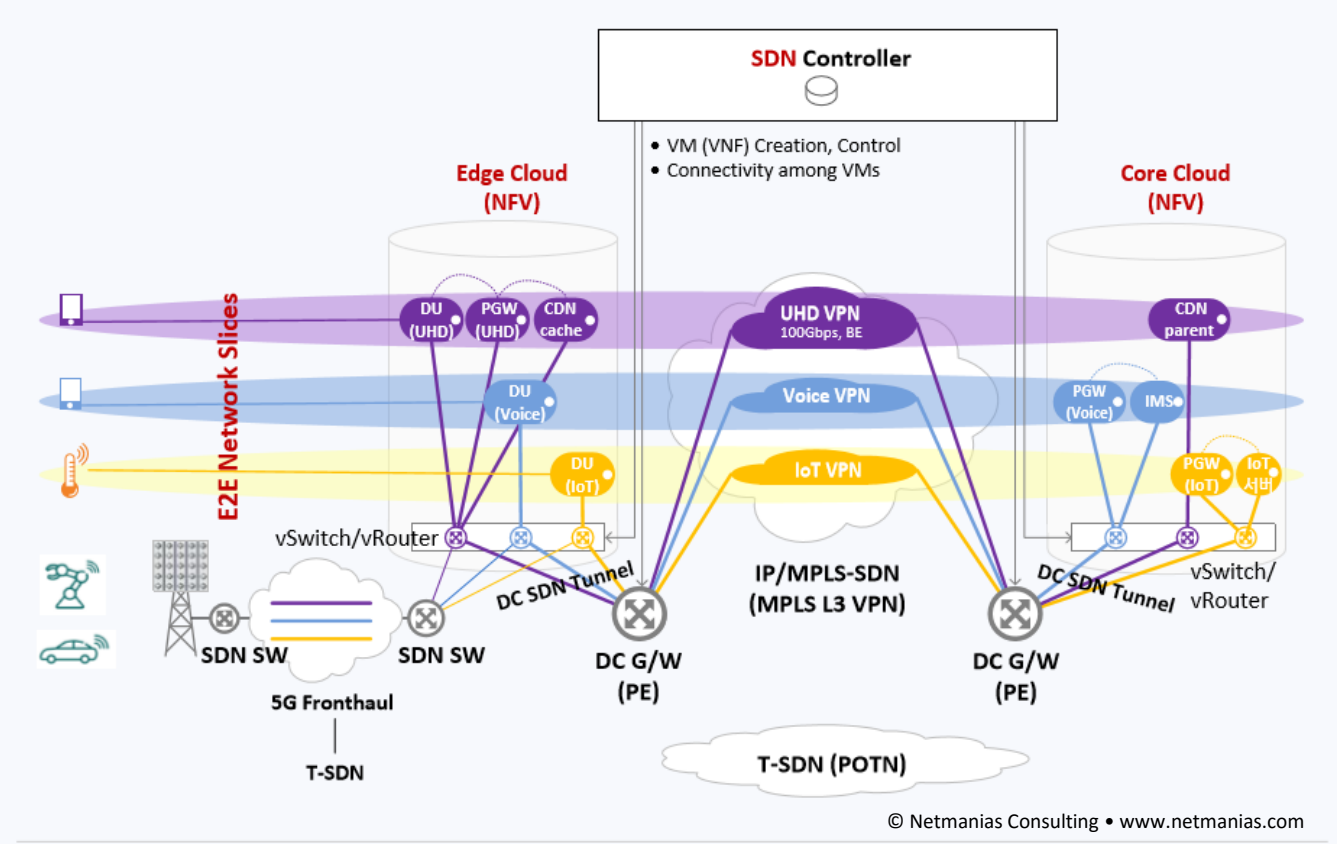
ENORMOUS TRAFFIC CONVERGING INTO THE CORE ⇒

DISTRIBUTED 5G CORE

5G RAN and Core: Network Function Virtualization (NFV)



E2E Network Slicing



The solutions will solve the scalability problem by upgrading the hardware to support multiprocessing methods and cloud ,but the storms will not been managed well because of the mesh topology network specially for IoT .

Speed up the LTE core control signals with spreading the jobs through the all network stages from the UE ,base station and the core network is the solution.

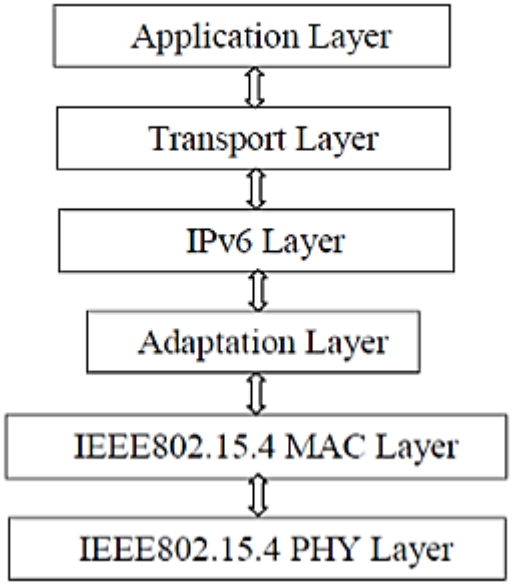
security will be managed by the new generation of distributed firewalls .

IPv6 over Low-Power Wireless Personal Area Networks (6LoWPANs)

It is a communication standard that allows the low-power devices to communicate and exchange data via IPv6.

The benefits of using IP-based connectivity to form the sensor access network:

- IP connects easily to other IP networks without the need for translation gateways or proxies.
- IP networks allow the use of existing network infrastructure.
- IP is proven to work and scale. Socket API is well-known and widely used
- IP is open and free, with standards, process and documents available to anyone. It encourages innovation and is well understood.



Reference model of 6LowPAN protocol stack

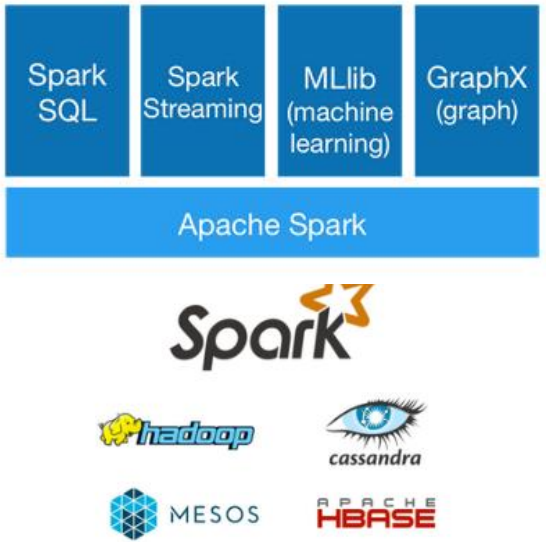
Apache Spark

Apache Spark™ is a fast and general engine for large-scale data processing.

Ease of Use
Write applications quickly in Java, Scala, Py

Generality
Combine SQL, streaming, and complex analytics.

Runs Everywhere
Spark runs on Hadoop, Mesos, standalone, or in the cloud. It can access diverse data sources including HDFS, Cassandra, HBase, and S3.



Hadoop YARN

Apache Hadoop 2.0 YARN (Yet Another Resource Negotiator)with :

- ✓ Its distributed processing framework for rebuilt cluster resource manager that ends Hadoop's total reliance on MapReduce and its batch processing format.
- ✓ Its feature as the fastest operating system because of its Spark .
- ✓ And as it has been used by yahoo and many companies for managing big data.
- ✓ And with its open source feature.

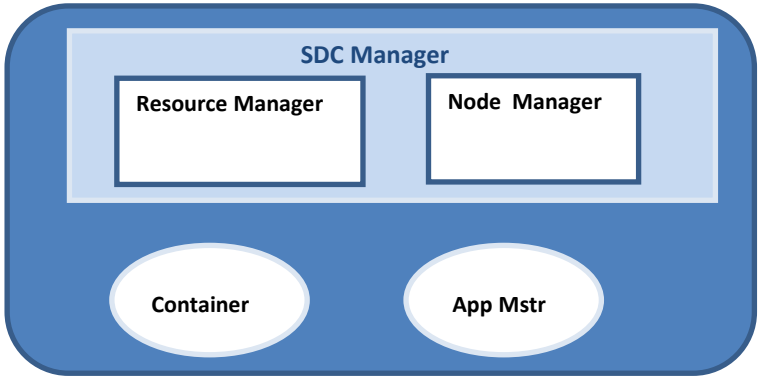
Would Drive it to be the standard operating system for DSC at 5G networks

Signaling Delivery Controller (SDC)

Manage nodes signaling by Signaling Delivery Controller (SDC) at all network elements from UE ,base station and core network stages.

SDC contains :

1. SDC Manager :
    1. Resource Manager.
    2. Node Manager .
2. Container.
3. Application Master .



Signaling Delivery Controller (SDC)

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- **CONCLUSION**

CONCLUSION

The new challenges at the LTE 5G network in managing the huge number of connected devices with big data rate handling and analyzing in a secure manner rises the needs for separating the functionalities in order to effective network control and avoiding problems such as storms.

So merging of the big data technologies with telecom network is the best solution.

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