Seizing the IoT opportunity

The Internet of Things (IoT) encompasses so many applications and technologies that it can be overwhelming. Wi-Fi, Bluetooth Low Energy (BLE), Zigbee, LoRaWAN, Sigfox, NB-IoT, Cat-M1, LTE Cat-1...

If we ask the question, how can a mobile service provider make money and grow with IoT, then our discussion focuses and the answer is clear. Cellular IoT (CIoT) specifically LTE technologies, Cat M1 and NB-IoT, provide the path to IoT growth and profitability for mobile service providers.

Unlicensed, fast-to-market technologies, such as LoRaWAN and Sigfox, have helped stimulate the IoT market in a few countries, but they will struggle to compete with LTE and future 5G CIoT technologies that can be added to millions of existing cell sites via software upgrades. Low power, short range, unlicensed technologies, such as Wi-Fi, BLE and Zigbee, may carry the lion’s share of IoT traffic, but it is challenging for service providers to make money with these commoditized, unlicensed solutions unless they are bundled with a CIoT LTE offering.

An Overlay IoT Core Network – C-SGN

Mobile service providers have rightly focused on the LTE radio technologies – existing LTE Cat 1-6+, Cat M1 and NB-IoT. However, it is also necessary to understand how these very different LTE CIoT technologies will impact their core network. Fortunately, the 3GPP standards groups have defined the Cellular IoT - Serving Gateway Node (C-SGN). A C-SGN, such as Casa’s Axyom C-SGN, that does not simply implement the standards, but delivers optimal CIoT performance and efficiency is essential.

To understand the need for a C-SGN, let’s examine in Figure 1 and note the different types of IoT traffic, their unique traffic characteristics, and the most suitable technologies for each IoT traffic type. The chart below also compares CIoT traffic with current 4G broadband wireless traffic in an effort to highlight the differences.

### CIoT Traffic Characteristics

<table>
<thead>
<tr>
<th>Applications</th>
<th>Sensors</th>
<th>Tracking</th>
<th>Monitoring</th>
<th>4G Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet Size / Throughput</td>
<td>10s to 200 bytes</td>
<td>10s to 1000s of bytes</td>
<td>up to 1 Mbps throughput</td>
<td>up to 10s of Mbps throughput</td>
</tr>
<tr>
<td>Latency</td>
<td>Delay tolerant</td>
<td>Existing LTE Latencies or Lower Latencies (&lt; 5ms)</td>
<td>Existing LTE Latencies</td>
<td>Existing LTE Latencies</td>
</tr>
<tr>
<td>Frequency</td>
<td>Rare contact – once a day to once a year</td>
<td>Rare to Sub 1 minute</td>
<td>Rare to Constant</td>
<td>Varies</td>
</tr>
<tr>
<td>Other</td>
<td>Low cost, Low power – battery, stationary</td>
<td>Mobile, High reliability</td>
<td>Efficient data transfer, Mobile &amp; stationary</td>
<td>Optimized for speed and capacity</td>
</tr>
<tr>
<td>CIoT Technology</td>
<td>NB-IoT</td>
<td>Cat-M1, LTE Cat 1</td>
<td>LTE Cat 4 – 6+</td>
<td>N/A</td>
</tr>
</tbody>
</table>
With CIoT, “one size does not fit all”. Each of the LTE IoT radio standards has a role to play:

- Narrow Band – IoT (NB-IoT) is optimized for fixed, ultra-low power sensors
- Cat-M1 supports low throughput, mobile devices
- LTE Cat 4 to 6+ are needed to handle high throughput IoT devices and gateways that support video and high-speed data.

NB-IoT deserves special attention since its goal is to enable billions of battery powered sensors that will operate in the field for 10 years or more. NB-IoT is a large commercial opportunity, but it puts new requirements on the network and requires us to rethink the mobile core if the full potential of NB-IoT is to be achieved.

**Can the current EPC handle the different CIoT traffic types efficiently? The answer is absolutely not.** Existing EPCs were designed to handle current 4G wireless traffic driven by smartphones as shown on the right side of Figure 1. How could a legacy EPC possibly handle the new and extreme IoT requirements? Being specific, here is a list of reasons why legacy EPCs will inhibit CIoT growth:

- **High Cost Points** – A low IoT cost point is needed to match the low IoT Price point. With NB-IoT sensors, some carriers are proposing prices of $6 per year or less. Legacy EPCs are priced to support millions of high ARPU smartphones not billions of low ARPU sensors.
- **Not Scalable for Security** – Legacy EPCs are not designed to provide large scale tunneling & security.
- **Not Ready for NB-IoT** – They cannot be re-architected to support the unique requirements of NB-IoT discussed below.
- **Not Ready for 5G** – There is no path to Session Based Architecture & Network Slicing with a Legacy EPC.
- **Not Optimized for Small Packet Processing** – NB-IoT packet payload size can be 20 bytes or even lower. Greater processing power is needed to handle all of the signaling generated, but also new approaches to reduce processing, such as the storage of S1 UE contexts within the MME.

The C-SGN is a recognition that a new solution and a new node is required. If you are trying to seize the CIoT opportunity and have not taken a close look at whether your legacy EPC is up to the task – watch out.

**What is the C-SGN and how can it provide a competitive advantage?**

The C-SGN architecture (Figure 2) was introduced in 3GPP Release 13 -- it is new and it is very powerful.
Figure 2 highlights what we believe will be the most common C-SGN use case options.

Most significantly, Figure 2 shows that the C-SGN provides a new path for CIoT packets. This path is shown in green and consists of the S1-Lite connection between the eNodeB and MME and the T6a connection between the C-SGN and the SCEF. This new data path was introduced to optimize NB-IoT traffic by taking the NB-IoT traffic over the control plane as non-IP traffic. The use of non-IP traffic seems odd at first glance – isn’t all data traffic IP? It isn’t – an example is SMSs, which are very efficient and are non-IP.

Figure 3 shows that the size of the IP header becomes an issue with small data packets generated by sensors. Every additional byte means that more power is consumed by the battery powered NB-IoT sensor. The large IP header rapidly drains the sensor’s battery.

The C-SGN is all about efficiency. It uses the control channel and the non-IP traffic path to reduce the number of packets processed by the NB-IoT sensor and as a result, increases the sensor’s battery life.

The C-SGN also handles IP traffic over the SGi interface and supports header compression for efficiency wherever possible.

If your competitors introduce NB-IoT using an inflexible legacy EPC, they will have an inefficient offering that shortens the life of sensors in the field. A C-SGN can provide a true competitive advantage.

Why Casa’s Axyom C-SGN?

Casa’s Axyom C-SGN is a virtualized solution combining MME, PGW and SGW functions. Casa’s C-SGN Virtual Network Functions (VNFs) are based upon the Axyom Software Platform. For many vendors, network functions are virtualized, but they are just mirrors of their former physical selves. In the industry, this is known as the “lift and shift” model of virtualization. Casa realized that there is a better approach and that VNFs can be optimized for a virtual compute environment. As a result, Casa’s Axyom Software Platform was built from the ground up to eliminate the poor performance found with many competitors’ VNFs. The goal of the Axyom Software Platform is to deliver service providers with maximum performance and flexibility. Casa’s Axyom C-SGN has the following advantages:

- **Scalable without reducing performance** - Optimized for a virtual compute environment, Axyom provides superior performance with up to 5X greater throughput per vCPU. Combined with a “lean” vCPU configuration and both vertical and horizontal scaling, the Axyom C-SGN reduces server count resulting in lower OPEX and CAPEX.

- **Deployable in a centralized cloud or at the network edge** – Axyom delivers independently scalable control and user
planes that can run at a data center or at the network edge. If the Axyom C-SGN user plane VNF is located at the edge, latency can be reduced and performance can be improved.

- **Deployable as virtual machines, in containers or on bare metal**
- **Support for multiple APNs** – This eliminates the need for multiple EPC instances.
- **Support for 5G IoT standards** – As the core and air interface move to 5G, the handling of IoT packets will evolve. Casa’s flexible VNF implementation will allow for a smooth migration to the 5G NR and 5G Core standards.
- **Flexible deployment options** – The Axyom C-SGN can be added as an overlay to the existing EPC to handle NB-IoT data-only or can be added to process all IoT data. Efficient and cost-effective NB-IoT support may be the priority, but the Axyom C-SGN will also improve the handling of all CIoT traffic – LTE Cat 1 to 6 and beyond, Cat M1 and NB-IoT.

**Summary**

The growth of IoT and the introduction of NB-IoT have created a significant business opportunity for service providers. NB-IoT will support billions of sensors whose batteries must last for a decade or more in the field. Although the industry has focused mainly on the new IoT air interface standards, it is critical to optimize the core to handle the deluge of small packets. Legacy EPCs are not up for the task. A C-SGN is essential to enable the full potential for NB-IoT and IoT growth in general.

Casa’s Axyom C-SGN is based upon the Axyom Software Platform, a powerful, efficient and flexible virtualized solution that provides leading throughput and small packet handling performance.

**Casa’s Axyom C-SGN Specification Highlights**

- Fully compatible with 3GPP R13 cellular IOT with GTPv2 support
- Support for NB-IoT and Cat-M1/M2 devices including enhancements to S1-AP, NAS signaling, GTP-C, S6a procedures
- CIoT Control Plane Optimization
  - Transport of encapsulated user data over the Control Plane in the form of NAS-PDUs
  - T6a reference interface
  - Transport of user data (IP or Non-IP) via NAS messages
  - PSM, eDRX and Extended ISR
  - Ciphering and integrity protection of user data
  - High latency communication where appropriate for delay tolerant sensors: buffers MT data and delivers to UE. TAU handling
  - ROHC profiles: IP (up to 2 IP addresses), UDP, RTP defined in RFC 3843
- Supports up to 11 EPS bearers per UE
- PDN or non-PDN based connections
- IP over control plane
- Non-IP over control plane
- IP over data plane
- Non-IP over data plane
- Service Capability Exposure Function (SCEF)
- Network-initiated connection established
  - SGi or SCEF-based
- Cellular IOT Roaming