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Innovation Services

An introduction to

Cellular IoT

A successful cellular connection of your medical device

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The ubiquity, reliability and security delivered by 5G enables seamless connected care. With the right information and guidance your medical device can be connected fast and easily.

We live in a world that is more connected than ever and healthcare is no exception. By delivering connected health solutions, a whole new experience can be brought to the patient and care giver, whereby the person is in the center of a personalized and quality care. Enabling such individual improved care requires atechnology that is ubiquitous, reliable and secure (high quality of service). All of this can be widely met by Cellular IoT (Internet ofThings). Hereby, cellular networks that are typicallyused for smartphones, are used simultaneously for physical objects in other industries.

The biggest advantage of using cellular networks for your physical objects is that you are connecting to existing networks. There is no need to build new infrastructure. 4G is already usable and 5G is on the horizon. This means good connectivity right now and even better, faster and more reliable connectivity in the near future. The proven resilience of the 4G and 5G networks makes a cellular connected medical device truly appealing.

When developing a cellular connected medical device, you have a vast variety of wireless technologies to make it IoT connected. You have to understand their strengths and weaknesses in order to choose the technology that will seamlessly and flawlessly connect your device to the cloud.

The advent of 5G will pave the way of seamless connected care. Continuous remote monitoring, real-time acute and chronic care or improved emergency services are just a few of the use cases that 5G will cover. In particular, two novel massive IoT technologies will empower these use cases: LTE-M (Long Term Evolution for Machines) or NBIoT (Narrowband-IoT). Both are already commercially available and coined as '5G ready' technologies. As opposed to other wireless technologies they offer worldwide coverage, including increasingly roaming agreements. No special configuration is needed, the product will just connect 'out of the box', increasing the usability of your product. In addition, with the proper design and analysis your product can last several years on battery.

Cellular IoT will enable hospitals and healthcare providers to make better use of resources and offer better care to the patients at lower cost. But it can be a challenging task, due to the stringent requirements for security, privacy and regulatory compliance. To make the implementation of IoT cellular services successful, one should combine expertise in connectivity technologies, the cloud, IoT security and regulatory.

In the next sections we present the different challenges you can run into when connecting your healthcare devices via cellular IoT – and how to tackle them.

1. Feasibility analysis

You are probably wondering if your cellular healthcare product can run on battery for one year; what is the achievable throughput or what is the cloud service latency?
There are many critical cellular parameters that will affect the performance of your healthcare product. To name a few: power saving timers (PSM), Discontinuous Reception timers (DRX), presence or absence of Release Assist Indication (RAI), frequency bands, communication protocols, Cellular IoT technology, support for Coverage Enhancement (CE) modes, transmit power, embedded or traditional SIM card or the efficiency of the modem boot up.

Insights in these cellular parameters is necessary to optimize the performance of your IoT connected medical devices. Our fully automated test framework will be helpful. It takes all these inputs into account and performs multiple endurance and accelerated tests. These tests can run from days to weeks and build thorough statistics at different times of the day for different operators and modems. The main aspects analyzed by the test framework are:

- **Battery lifetime**
  An extensive analysis is shown depending on the communication protocol, the network timers or the Cellular IoT technology.

- **Packet loss**
  An exhaustive examination of packet loss for different communication protocols is presented.

- **Latency**
  Whether your product has real time requirements or it is more relaxed, you always want to know the expected delay to reach the cloud.

- **Analysis of peak currents and battery selection**
  Will your battery be able to cope with the surged peak currents generated by Cellular IoT technologies? By plotting 3D graphs, we can analyze the duration and intensity of those peaks so that the most appropriate battery can be selected.

2. System architecture

Having your healthcare product connected to a cellular network could be a daunting task. Keep these aspects in mind while setting up a seamless direct-to-cloud cellular connection:

- **End-to-end architecture**
  Making a cellular connected healthcare solution requires several components: the infrastructure from the mobile operator, an intermediate proxy server (not always required) and the cloud. The choice of these components will certainly have an impact on security.

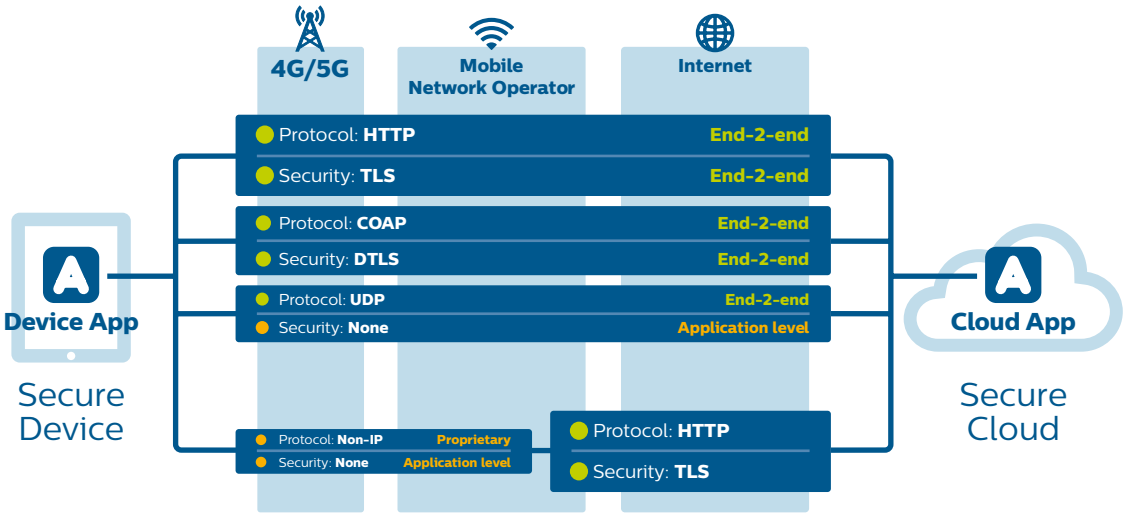
- **Communication protocol selection**
  Each protocol has different impact on the security, throughput, packet loss and battery lifetime of your product. For instance, sending your data using HTTPS will have different implications in security and performance than if CoAPs (CoAP over DTLS) is used.

- **Cellular IoT technology selection**
  The advent of 5G will unlock the potential of the Internet of Things by enabling more connections at a very low power. However within 5G, many detailed aspects still must be considered: shall the product use LTE-M or NB-IoT? Or perhaps, traditional LTE? Which technology will offer the best performance and worldwide coverage for my healthcare proposition?

- **Mobile network selection**
  Shall the product use one operator worldwide or one per country? Will the product perform similarly in terms of battery in every country? Is the operator offering worldwide coverage? What is the most convenient tariff model for my product?

- **Modem selection**
  There are more than 15 different manufacturers offering Cellular IoT modems. Each manufacturer offers several solutions for LTE-M, NB-IoT and traditional LTE. Comparing them is useful in search of the best manufacturer and modem. We can support you with the selection by analyzing and comparing frequency bands, low power features, end to end security, communication protocols, software integration, cloud support, hardware integration and maturity.

End-2-end communications in Cellular IoT



* Thickness of bars are an indication of the amount of energy and data used.

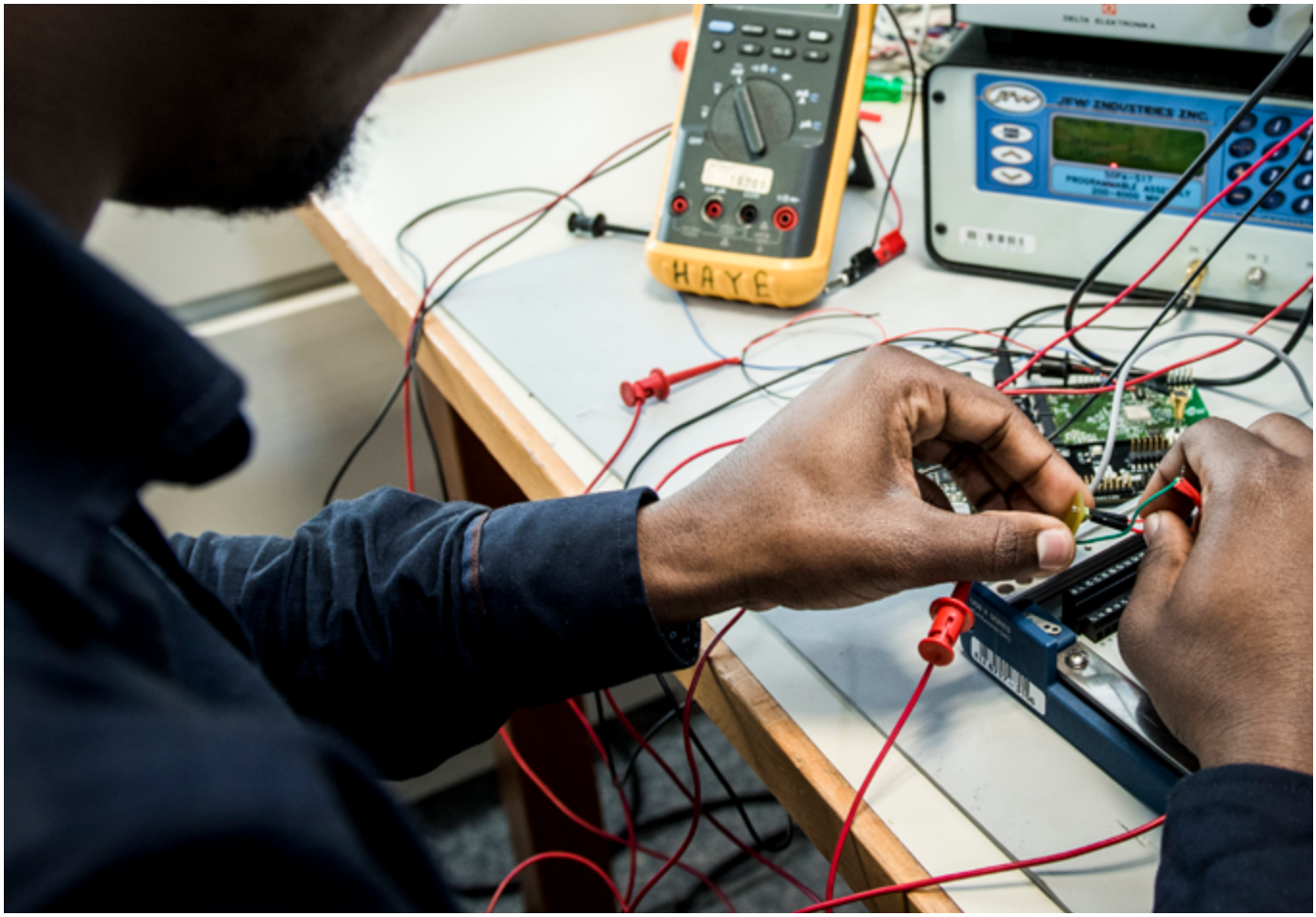
3. Design & prototyping

A prototype of your product with cellular functionality provides you with critical information of successes and improvements. It should consist of integrated hardware (electronics, antenna and radio chips) and software. Also during this phase, design for cost is important. Trying to find components at a lower price, without compromising the quality of the product.

As well as a fully functional connected prototype, we also provide valuable information about antenna design and electronic PCB design.

- **Antenna design**
  Design guidelines based on dedicated 3D electromagnetic modeling and simulations can be developed. This helps to understand the physics and to optimize your antenna integration and RF design, cost and time efficiency.

- **Electronic PCB design**
  An electronic schematic and a PCB (Printed Circuit Board) layout can be developed. Also key component selection is part of the procedure (antennas, radio chips and modules, etc.)



4. Cloud integration

A fully operational telehealth solution requires integrating your cellular connected healthcare product with a cloud that allows to close the loop with your patients. However, such integration can be complex.

Philips HealthSuite Digital Platform (HSDP) offers regulatory compliant cloud infrastructure and platform-as-a-service for medical applications. It provides you with cloud expertise and capabilities to connect devices, the ability to collect electronic health data, aggregate and store data securely, analyze data and create solutions on the cloud. Leveraging the services of HSDP we can develop with you solutions including:

- **End-to-end connectivity**
  The communication protocol can have a great impact on several aspects of the product. Such protocol could be supported in the cloud. Otherwise, a proxy server might be required between the mobile network operator and the cloud.

- **Data format**
  Is the data format efficient for your IoT solution? Can it be reduced to a minimum number of bytes such that your product is still uniquely identifiable and the main functionality does not get affected?

- **Services in the cloud**
  Which type of data do you want to store in the cloud? Do you want to keep track of all your connected devices? Does your solution require the ability to support firmware upgrades over the air? How are the devices going to unequivocally authenticate themselves in the cloud?

5. Review of your cellular connected medical device

When your healthcare product is connected, it might be useful to seek for a second opinion. An extensive analysis of your healthcare proposition gives you worthy insights about your IoT cellular services. It might lead to smart improvements.

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