Manufacturing the Internet of Things
1 - Introduction

The Internet of Things (IoT), along with 5G, are “the next big thing” in the Tech World. Many industries are excited about the opportunities it presents, worried about the changes and perplexed by the challenges.

Most of the discussion around IoT within the manufacturing industry is related to the manufacturing flexibility that the Smart Factory will produce and the logistical efficiencies that real-time process tracking will enable. Less discussion has taken place on the subject of manufacturing the very Things that make it all possible: connected things.

If you ask 10 people what The Internet of Things means you are likely to get 10 different answers ranging from Big Data to the connected car and autonomous driving. Still, one common denominator remains: The Internet of Things relies on products that are physically connected to the outside world. Be it wired or wireless, without this connection the Internet of Things will not exist.

In this paper we will discuss some of the Test and Measurement challenges that the industry will need to tackle in manufacturing the Internet of Things.

2 - Wireless Technologies for IoT Applications

Even if the realm of possibility for the IoT seems infinite it will be enabled by a finite number of Technologies. In this paper we will focus on the radio frequency (RF) technologies enabling a wireless connection.

The wireless technologies enabling the Internet of Things can be roughly divided into 3 groups though with some overlap:

- Cellular, meaning technologies evolved from mobile telephony
- Non-cellular, meaning technologies derived from standards such as Bluetooth or WLAN
- IoT specific, meaning technologies developed specifically with IoT in mind

<table>
<thead>
<tr>
<th>CELLULAR</th>
<th>NON-CELLULAR</th>
<th>IoT SPECIFIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G</td>
<td>Bluetooth</td>
<td>LoRa</td>
</tr>
<tr>
<td>3G</td>
<td>WLAN</td>
<td>6LoWPAN</td>
</tr>
<tr>
<td>4G</td>
<td>Zigbee</td>
<td>Weightless</td>
</tr>
<tr>
<td>5G</td>
<td>Z-wave</td>
<td>NB_IOT</td>
</tr>
<tr>
<td>WIMAX</td>
<td>UWB</td>
<td>NFC</td>
</tr>
</tbody>
</table>

Table 1
The optimal choice of technology or combination of technologies depends on the use case of the end product. Most IoT solutions are projected to be relatively close range connected, typically tens of meters at most. These products will not benefit from a long range Wide Area Network connection and will likely use non-cellular technologies such as Bluetooth Low Energy or Zigbee or possibly the point-to-point connections envisioned in the future for 5G. Longer range connections can be provided by cellular or low power WAN technologies such as LoRa, NB-IOT (a 4G LTE derivative) or 6LoWPAN.

In addition to range one key factor to consider in choosing the right technologies is the reliability requirement of the end application. A connected coffee cup using Bluetooth Low energy to transmit the temperature of your beverage will have a very low reliability requirement. A connected car using multiple types of sensors and high data rate, real time connections to enable autonomous driving will require extreme reliability and extensive testing and quality assurance in the manufacturing phase.

3 - Varying Testing Needs

The amount and complexity of testing of IoT devices will vary immensely depending on the technology combination chosen for the product and the reliability requirements discussed above.

![Figure 1: Testing complexity referenced to required data throughput and reliability](image)

Within the realm of IoT devices there are certain to be a very large quantity of products that have close to no reliability requirement and thus will have very little functional testing performed, possibly only a connection check. On the other end of the spectrum are complex, high reliability, critical applications where tests will need to be carried out with extreme diligence, often with purpose-built, proprietary test systems. The cost of test will follow the same path.
The space in between, from a test and measurement point of view, is interesting. There will be many types of IoT applications that will require proper functional testing but will not be able to support the cost of building a proprietary test system for each product or project.

What could be done in the design and manufacturing phase to reach the required quality metrics without driving up the cost of test?

4 - Customer Differentiation/Variety

As the Internet of Things envelops such a wide variety of industries it is clear that most companies entering the IoT world will not have electronics design and manufacturing as their core competence. Software, machine tools, logistics – there is no industry that is not affected. However they will still need that physical connection to be designed and manufactured.

The logical way to get this done is to work with a partner who has the expertise to either build a connection into an existing product or design and manufacture a new connected product. The EMS industry will likely evolve to work with customers not only as a manufacturing partner but also as a consultant to guide the customers to the quickest, most economical path toward launching their hardware product.
This means a lot of new opportunities for capable EDM/EMS companies. However, the challenge is in serving a high number of customers with speed and efficiency. On the other hand the needs of said customers are somewhat similar: They all need that connection.

5 - Product Variety in Manufacturing

The use cases for IoT reach from the bottom of the sea into space. As the scope of solutions is so broad it is inevitable that many different types of products are required to enable each idea to reach its full potential.

In a traditional manufacturing setting a particular type of product or product family will have a production line all its own, including any test instrumentation. Each product would also have a custom designed proprietary test solution optimized for that production line alone. Customizing the test solution per product can have economic benefits in the short term but may lead to asset management issues.

The test solution normally includes test instruments, software, test fixtures, cables and other hardware. The hardware and software content of the solution traditionally depends on the testing requirement of the end product.

In this case scaling up production means investing into a new test setup once the throughput limit of the current ones is reached. In the case of scaling down production - since a test setup is developed for a particular product – it is difficult to transfer the invested assets to produce and test another product. Once a project ramps down the assets often become obsolete and cannot be transferred.

Also: If the testing solution needs to be developed and built from scratch for each and every customer this makes for a longer time to market as well as sets an economic barrier for smaller projects which might eventually become huge.

Is there a way to make more efficient use of the assets used in testing?

What could be done to enable more efficient ramp-up and ramp-down of production volume?

Is there something that could be done to reduce the time and cost of test development?
Flexible Solution for Manufacturing the IoT

The testing of IoT devices does not have to be all that complex. Wireless IoT technologies are many but the production testing for all of them is handled in a very similar manner. This means that a huge portion of the production test needs of the wireless IoT device world can be handled with one single solution: The Anritsu MT8870A.

The Anritsu MT8870A contains the technology needed to test almost any IoT device. The MT8870A is a modular, customizable testing platform that has ready-made software to support the most common IoT technologies today. With its modular hardware and software configuration the MT8870A can support your testing needs when and where you need them. Nice, but how can it help in making wireless device manufacturing faster and more economical?

The answer lies in the structure of the product itself and the capability of Anritsu to deliver a full solution to your testing problem whenever needed. Here’s how:

First: There is no IoT technology that the MT8870A cannot be made to work with. It is thus possible to run almost any IoT production test project using the MT8870A. This makes it faster to develop testing for production as many tests can be re-used with small modification per product specification.

Second: The MT8870A consists of a mainframe, measurement modules and measurement software. The modules can be added or removed as the need for test capacity is increased or decreased. If many production lines use the same test platform it is possible to transfer measurement capacity from one line to the other just by removing and reconnecting a module. It’s that easy.

Third: Anritsu is very experienced in helping our customers optimize their test solution for production. We can make your testing faster and more reliable when we cooperate with you. Anritsu products and software are renowned for reliability and stability over time.