



The Impact of Interoperability Testing

Paul Blackett

paul.blackett@ul.com

Topics

What is interoperability testing?

What types of products need interoperability testing?

Why isn't certification testing enough?

When is IOP testing most applicable?



Topics

What makes UL interoperability testing unique?

What is the return on investment?

How does this affect my brand and the end user?

Question & Answer



What is interoperability testing?

What is interoperability testing?

- Let's start with a definition...

UL defines interoperability as:

The ability of products, developed in isolation, to reliably connect and communicate with one another without specialized intervention.

- In other words...

The consumer's ability to take their new product out of the box, follow setup instructions, and the device is immediately able to reliably communicate with other devices as intended. This is delivering the on the Consumer Promise and builds Consumer Trust.

- And now for the acronyms...

Interoperability = IOP

Internet of Things = IoT



What is interoperability testing?

- At its core IOP is the testing of real world interactions between real products

Device to device testing

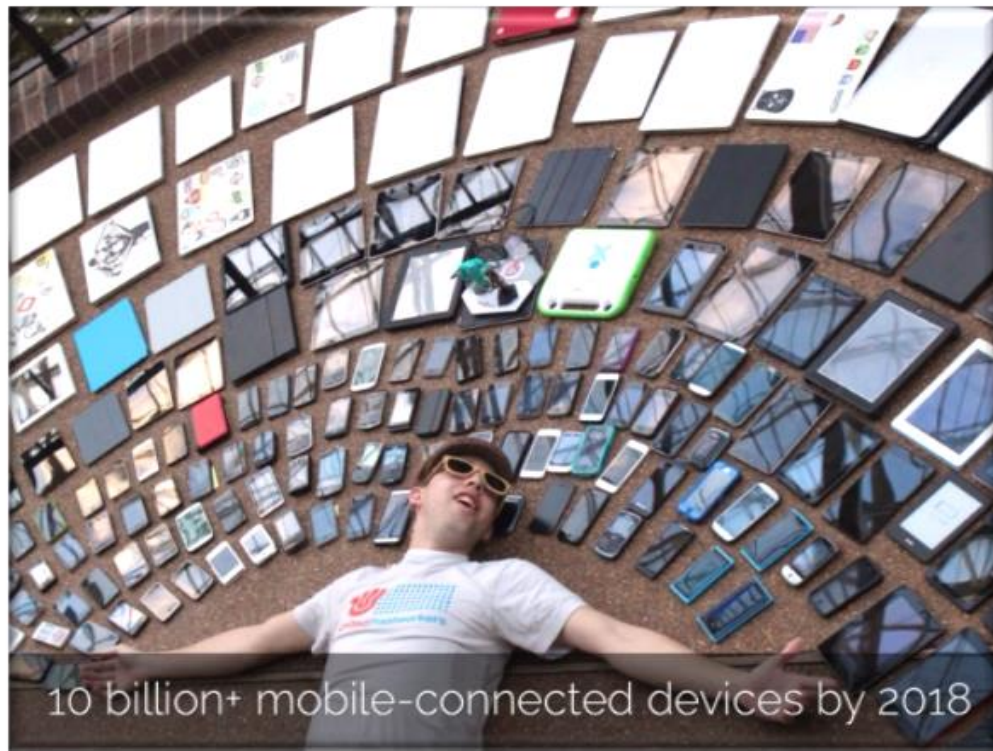
- UL IOP testing is designed to closely replicate the customer experience
 - The use of test equipment is intentionally minimized to stay true to the customer experience
 - Items like user guides, marketing claims, quick start guides and FAQs are all valuable inputs to a successful IOP program



IOP Takeaway

The simple goal of interoperability testing...

How do we keep this guy happy?



What types of products benefit from IOP?

What types of products benefit from IOP tests?

Wearables

Change is constant...

- New mobile phones
 - Different chipsets
 - Different protocol stacks
- OS updates
- App updates
- New Bluetooth features
- New network features
- Software updates



What types of products benefit from IOP tests?

Automotive Infotainment

Change is constant...

- New mobile phones
 - New chipsets
 - New protocol stacks
- OS updates
- CarPlay, Android Auto
- App updates
- New Bluetooth features
- New network features
- Software updates

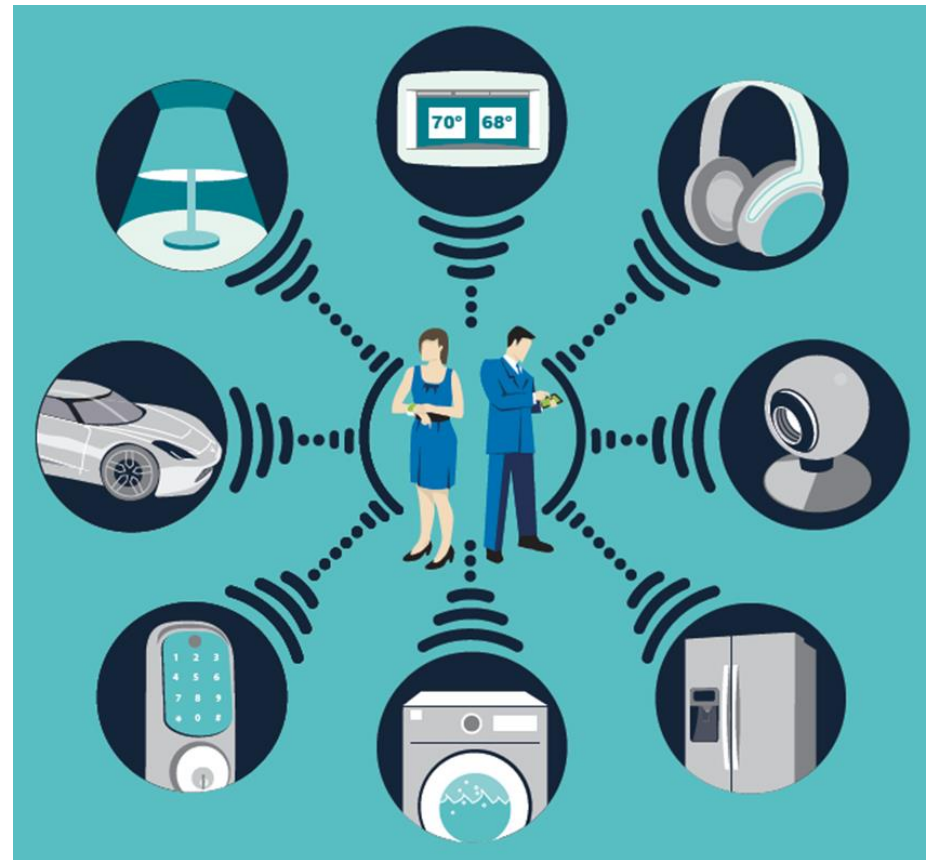


What types of products benefit from IOP tests?

IoT and Home Automation

The mobile phone is the gateway to the connected home

- Connection technologies
- More complex networks
- Increased expectations
- Higher consequences
- Ever changing landscape



IOP Takeaways

- The mobile phone variable is at the center of...
 - The wearable experience
 - The connected car experience
 - The IoT experience
- Change is constant: mobiles, OS updates, app versions, chipsets, use cases, etc.
- If you don't test your products for IOP, then who does?

Your customer



Why isn't certification testing enough?

Why isn't certification testing enough?

Different test objectives require different test tools

- Certification testing
- IOP testing



Figure 2-1. TYAD RF Test Platform



Why isn't certification testing enough?

- Certification testing and IOP testing are both important parts of the design process, but they have very different objectives
- **Certification testing – mandatory testing designed to ensure the product complies with the standard(s)**

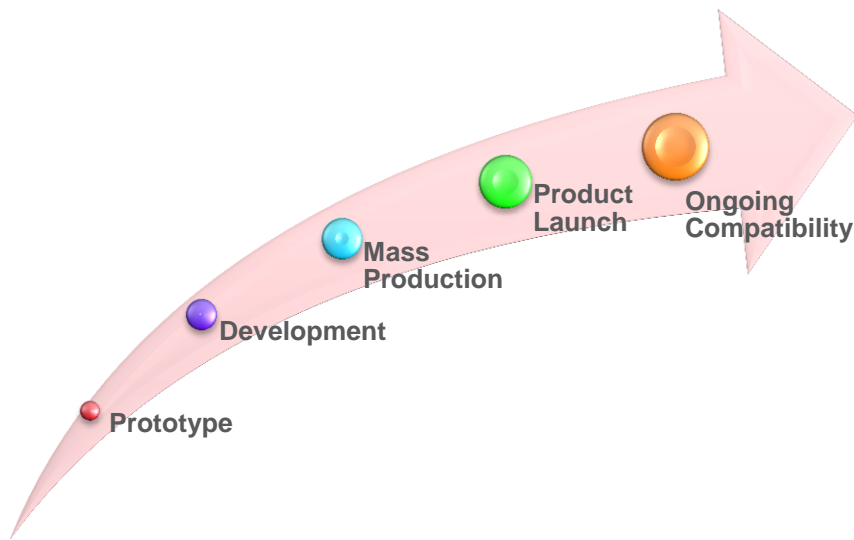


- **IOP testing – optional testing designed to ensure the product delivers on the consumer promise across a range of companion devices**



When is IOP testing most applicable?

When is IOP testing most applicable?



A robust interoperability program encompasses all phases of the product development cycle.

Starting with a stable prototype, following into mass production and finally ongoing compatibility until the product is end of life.

The test procedures and quantity of devices to test are customized at each phase.

When is IOP testing most applicable?

Test early and test often

- Stable Prototype
 - Early testing with a very small number of companion devices
 - e.g. 1 iOS device and 1 Android device
- Development leading up to mass production
 - In depth testing across a wide range of companion devices
 - Coverage for all flagship mobiles
- Product launch to end of life
 - Ongoing compatibility testing to verify functionality
 - Initially target embedded base of mobile users
 - Ongoing target newly launched mobile devices



What makes UL interoperability testing unique?

What makes UL IOP testing unique?

Testing Experts

- UL is a recognized leader throughout the wireless test and certification industry
- Authorized Test Lab & Active Standards Involvement



- Active Standards Involvement



OPEN
INTERCONNECT
CONSORTIUMSM



What makes UL IOP testing unique?

Invest in test

- In 2015 UL acquired the NAC (National Analysis Center)



- Since 2003 the NAC has been the de facto standard for interoperability testing in the US
- NAC interoperability testing is recognized by all US mobile network operators and many automotive companies



at&t

T-Mobile



What makes UL IOP testing unique?

Test philosophy

- The combination of UL and NAC leverages the best of both to create a unique test philosophy

Explicit vs. Implicit Testing

- Explicit: directly stated and leaving no question as to meaning or intent
- Implicit: understood though not clearly or directly stated
- Competitors only offer explicit testing while UL IOP includes both explicit and implicit testing



What makes UL IOP testing unique?

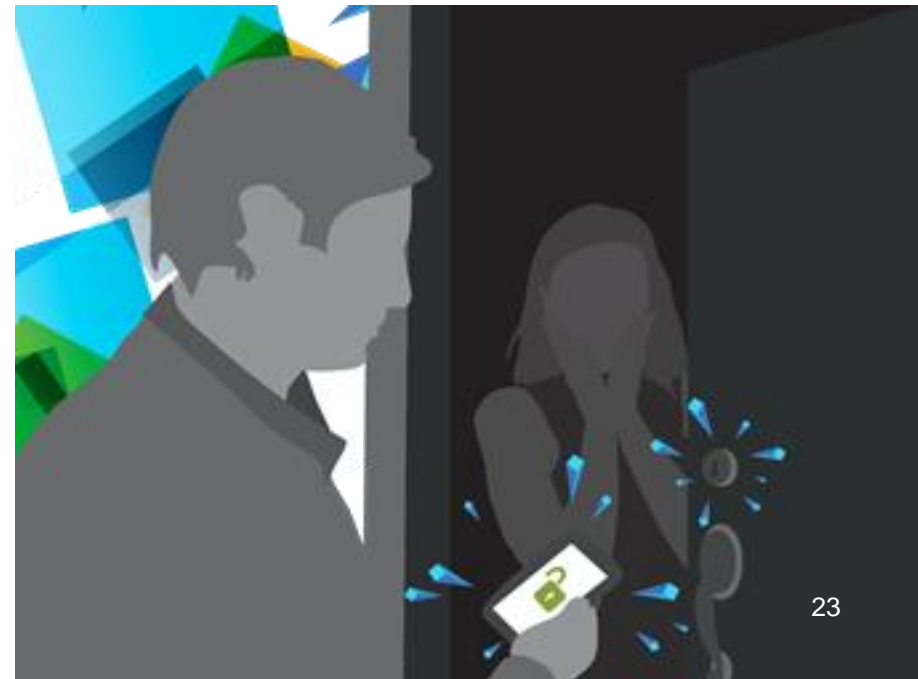
Test philosophy example #1

Wireless Door Lock

A wireless door lock has a novel feature that enables the owner to issue and revoke E-keys. This allows visitors to access the home using only their mobile phone.

However, when the owner revokes an E-key the visitor's key is not deleted until they try to use it.

Finally when the visitor does try the revoked E-key, the lock opens just prior to deleting the key.



What makes UL IOP testing unique?

Test philosophy example

Explicit Test Case

- Issue an E-key to a visitor
- Verify E-key access
- Revoke E-key
- Attempt to use E-key
- Verify E-key is deleted

Explicit result = PASS

The explicit action of deleting the E-key has occurred.

Implicit Test Case

- Issue an E-key to a visitor
- Verify E-key access
- Revoke E-key
- Attempt to use E-key
- Verify E-key is deleted **and lock does not open**

Implicit result = FAIL

The implicit intent of deleting a key is to prevent access.



What makes UL IOP testing unique?

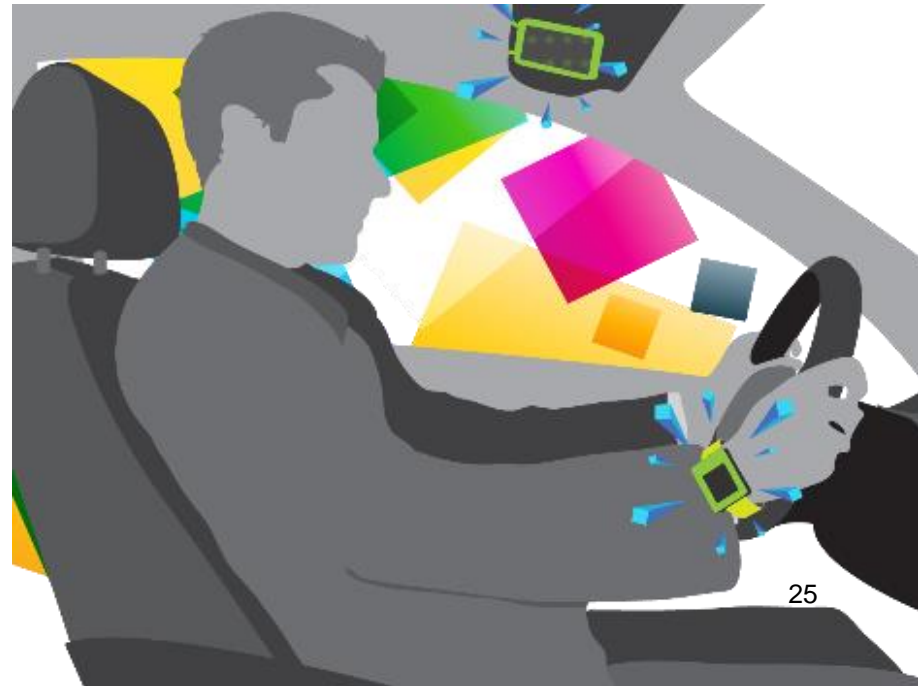
Test philosophy example #2

Automotive Infotainment System

A common automotive infotainment task is to handle an incoming call while listening to music. In this example the driver is listening to the radio while driving.

An incoming call is received, answered and ended by using the steering controls.

When the call is ended the phone incorrectly starts Bluetooth music, not returning to the radio music.



What makes UL IOP testing unique?

Test philosophy example

Explicit Test Case

- Listen to music
- Answer incoming call
- End call
- Music resumes

Explicit result = PASS

The explicit actions of call handling, music pause and resume have all occurred.

Implicit Test Case

- Listen to music
- Answer incoming call
- End call
- Music resumes **from original source**

Implicit result = FAIL

The implicit intent is to resume the same music playing prior to the call handling.



IOP Takeaway

Implicit Testing – also known as...

Testing without blinders on

- Blinders: a limitation or obstruction to judgment or discernment
- UL IOP testers are specifically trained how to test from the point of view of the customer
- If any customer affecting issues are observed, they will be reported
 - **Even if outside the scope of the test plan**



What makes UL IOP testing unique?

Root cause analysis

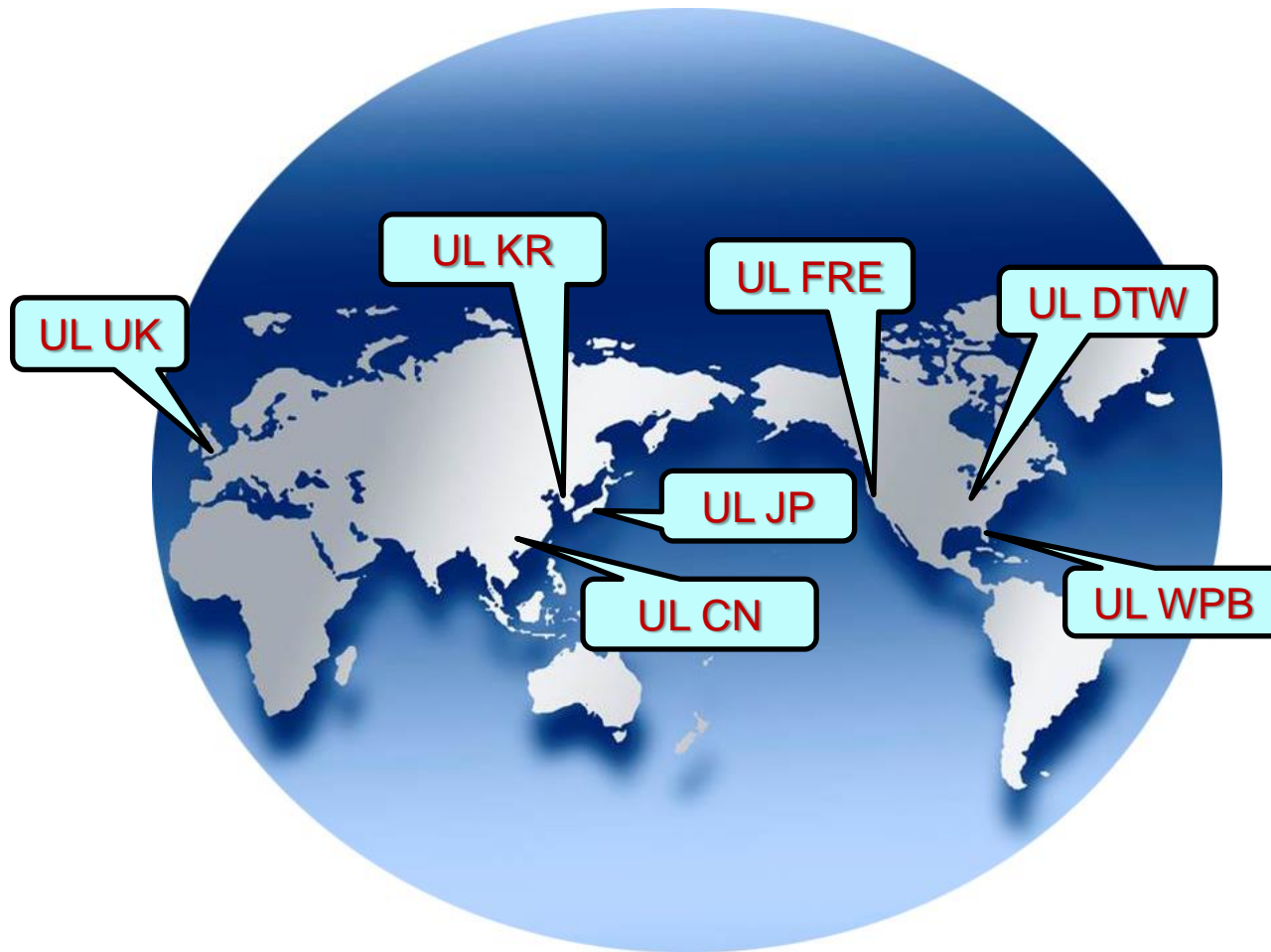
- Just identifying a failure is not enough
- UL IOP includes a root cause analysis for all failing test cases
- Since this is device-to-device testing, it is critical to understand which device caused the failure

UL subject matter experts have the knowledge and the tools to detect the failure and identify which device is causing the incorrect behavior



What makes UL IOP testing unique?

Global coverage



What is the return on investment?

What is the ROI?

Orders of magnitude

Remember our example from earlier...

When the call is ended the phone incorrectly starts Bluetooth music

- This phone related problem resulted in millions of dollars of loss to the automotive manufacturer
- The cost to test this at beta was estimated in thousands

\$10,000's

vs.

\$1,000,000's



What is the ROI?

Orders of magnitude

A similar situation occurred with wearables and Android mobiles

- A prominent electronics brand was getting ready to launch a new wearable that supported hands-free calling

During IOP testing it was revealed that many Android phones did not support the dual-HFP capability required to connect both the wearable and the car

- Decided to delay product launch



How does this affect my brand and the end user?

How does IOP affect the brand and end users?

Improved out-of-box experience

Have you ever been excited to bring home a shiny new gadget?

Only to be let down or frustrated by problems with the initial setup

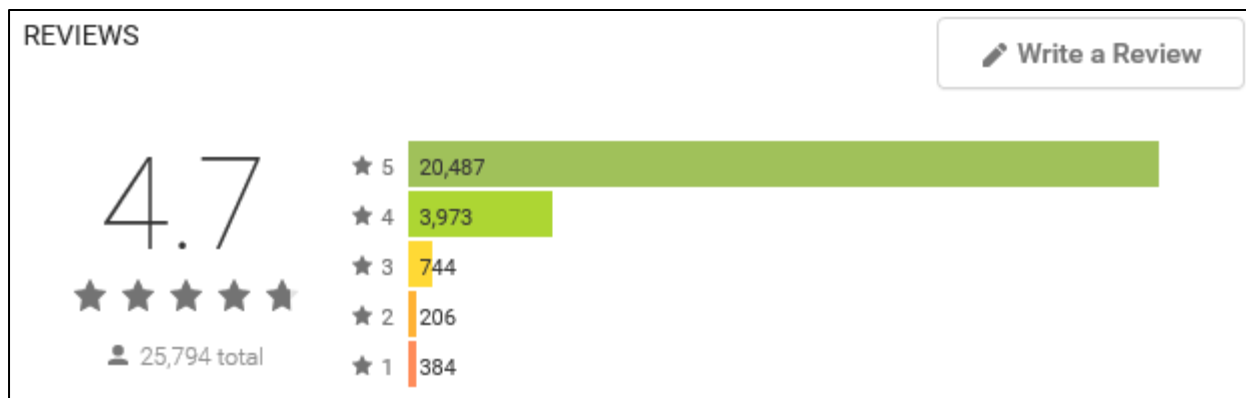
- OOBE: the **out-of-box experience** is typically the first impression a product creates, such as the ease with which a buyer can begin using the product
- IOP testing addresses the OOBE by ensuring the product has been thoroughly tested in the configurations customers will most often encounter
- OOBE can be another way to measure product NPS
 - In the IOP scenario you are able to gain perspective into how well the product performs in early life, and if there are gaps relative to the user's overall experience



How does IOP affect the brand and end users?

Better app store and online reviews

- A robust IOP program ensures that you have tested your devices with the most popular mobile phones on the market
- Broad IOP coverage on a global scale covers the majority of devices and networks that your device may encounter in the real world
- Fully IOP tested products translate into higher reviews on app stores and more positive blog reviews



How does IOP affect the brand and end users?

Brand Protection

- You never get a second chance to make a first impression
 - This is especially critical for new brands delivering their first products
 - Crowd funding websites a loaded with dreadful stories of companies shipping untested product that kills both the brand and the company

Kreyos Smartwatch- A company that raised \$1.5 million in funding

The Rise and Fall of KREYOS

First things first: I want to offer my sincerest apologies to all the backers and customers who pledged for or pre-ordered the Kreyos Meteor.



FAQ



Q1. Is Interoperability testing automated?



A1. Testing can sometimes be automated but remember the explicit Vs implicit test cases. Implicit testing requires a trained test engineer to be able to see and identify unexpected or unusual behavior.



Q2. During interoperability testing can you also evaluate the quality of the product either standalone or against other products in the marketplace?

A2. It is possible for us to evaluate your product against another commercially available product. We also have benchmarking services to evaluate the performance of products. This is not really covered in this webinar so if you require this service please contact us and we can discuss more



Q3. How many testers does UL have for IOP and how do we coordinate the user experience evaluation to minimize subjectivity?

A3. UL has a growing pool of testers currently about 50 globally. Most of the testing is based on over 13 years of lessons learnt and this is covered in a lot of our test plans.

Our engineers also go through a training program so they can identify issues that could cause a problem for consumers. This training is proprietary but is also built on experience and industry knowledge.

In essence the testers rely on training experience with a thorough review by our industry leading experts before the results are released

Q4. Will a UL Certified product meet the IOP requirements by default or does this need to be requested separately?



A4. Interoperability testing is not mandatory and so UL`s certification programs will not guarantee interoperability. The certification or conformance testing a product goes through sets a low bar for interoperability and the market has driven the need for these additional services. Interoperability testing will need to be requested separately

Thank You



Please send any questions you may have to:

Paul.blackett@ul.com

Or

siyu.yan@ul.com

