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Single Use Mobile Devices In Healthcare:
A complete guide to choosing your mobile infrastructure

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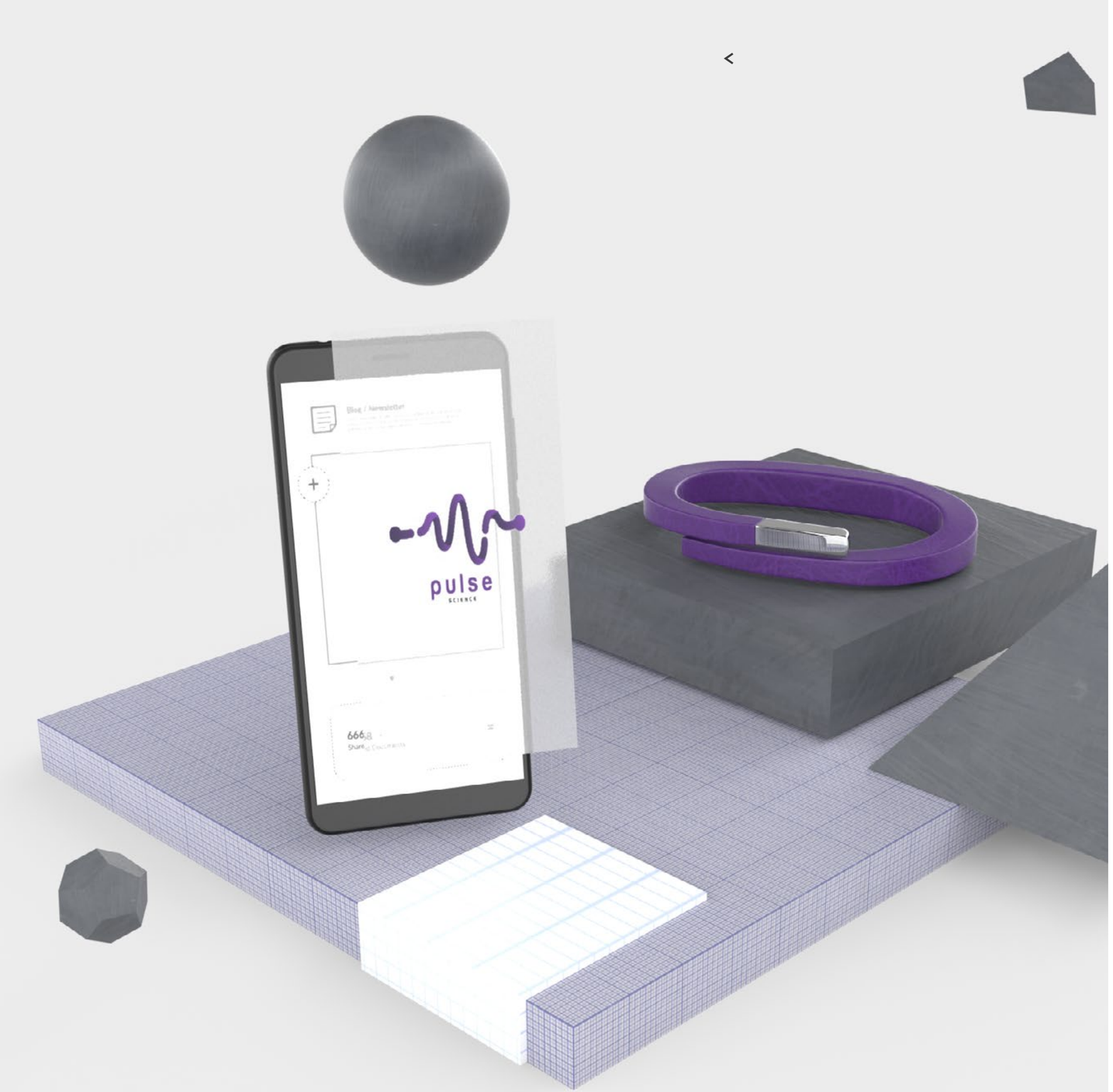

NEXT UP...
WHAT IS MOBILE INFRASTRUCTURE?

Over the past few years...

Over the past few years there has been massive adoption of single-use mobile devices in the healthcare space. Companies across numerous verticals - patient engagement, remote monitoring, clinical trials, medical devices, etc. - are leveraging advances in these mobile technologies to deliver their products on dedicated mobile devices.

These single-use devices help improve communication, streamline workflows, and lead to better data collection. All of these efficiencies contribute to an improved patient experience, lower readmittance rates, faster clinical trials, a more educated patient base... the list goes on and on.

Unfortunately, even though the adoption of single-use mobile devices has blossomed, the underlying tools and infrastructure for supporting the companies building these solutions has stayed stagnant. This ultimately makes it slower and more difficult to bring these innovative products to market.

Understanding these underlying technologies can have significant impacts on successfully launching a new product. After reading this report, you should walk away with an understanding of three key concepts:

- **What mobile infrastructure is**
  (i.e. the core components you need to deliver a single-use device)
- **The three most common infrastructure options**
  (i.e. what they are, and more importantly how they compare)
- **Key healthcare specific considerations when evaluating mobile infrastructure** (i.e. potential problems or opportunities do you need to be aware of)

This is meant to be a succinct and useful resource to help you better understand how to go to market with a product delivered on a single-use mobile device.

PART ONE

WHAT IS MOBILE-INFRASTRUCTURE?

What Is Mobile Infrastructure?

Mobile infrastructure is a relatively new concept that's grown over the past few years as enterprises have started to utilize mobile devices dedicated to running a single application.

In short, mobile infrastructure is the underlying pillars - hardware, software, and services - that go into supporting a single-use device. It consists of the hardware, operating system, device management software, and operational services (essentially everything except your application and any peripheral devices that may be part of your overall solutions - e.g. a heart rate monitor). Here's an overview of each element:

With these four components in place, the only thing that's left is your application and any peripheral devices that may be part of your solution (e.g. a heart rate monitor).

Hardware

The actual physical device that runs your application and provides an interface for the end user. In the healthcare space, you will see these range from consumer devices (smartphones and tablets), to custom made white-labeled devices (3" all-in-one touchscreen devices to 22" tablets).

Operating System (OS)

This is the OS that runs on the hardware - the layer between the hardware and your application .The two most common OS options are iOS and Android, with Windows as a third alternative.

Device Management

This is the software for managing, monitoring, and supporting your devices in the field. It typically allows you to deploy app updates, see the status of a device, and remotely view/control devices.

Operational Services

All the services that go into manufacturing, delivering, and supporting the hardware. Unlike cloud infrastructure - where servers are hosted in a handful of static locations - mobile devices need to be deployed to end-users all over the world. Supporting this includes forward and reverse logistics, cellular data plans, regulatory certifications, manufacturing/refurbishing, and more.

PART TWO

MOBILE INFRASTRUCTURE OPTIONS

	Consumer	DIY (do it yourself)	Mobile Infrastructure-as-a-Service
Hardware	**Consumer-of-the-Shelf (COTS)** *E.g. Apple, Samsung, LG*	**A custom device designed to your specs**	**Mobile IaaS portfolio device** *Each provider will have a different set of devices available, with different levels of customization options*
Operating System	**Android or iOS** *Occasionally windows for larger kiosks*	**Android** *Either provided by manufacturer (not recommended) or built in-house*	**Android** *Mobile IaaS providers have developer tools to build and customize your own Android OS*
Device Management	**MDM/EMM provider** *E.g. Airwatch, SOTI, MobileIron*	**Built in-house** *Some EMM providers can be customized for specific devices*	**Provided by mobile IaaS** *This tends to be table stakes for any mobile IaaS provider*
Operations	**Handled in-house or through a third party**	**Handled in-house or through a third party**	**In-house or provided** *Handled in-house or through your mobile IaaS provider*

Mobile Infrastructure Options

There are three main options when it comes to picking an infrastructure stack to support single-use mobile devices. These three options are:

Consumer
Consumer mobile devices paired with an MDM/EMM

DIY
A custom built device and operating system designed in-house and sourced straight from the manufacturer

Mobile Infrastructure-as-a-Service
An infrastructure offering combining enterprise-first mobile devices, developer tools to build a custom OS, and cloud services to manage your device fleet

In the table to the left you'll find an overview how each option puts together a complete infrastructure solution to help companies deploy dedicated devices.

Each solution has pros and cons depending on your product, company size, and vertical. So how do you decide which one is best for you?

The next section outlines the top elements you should consider related to hardware, software (OS + device management), and operational services. In the appendix, you'll also find a full table comparing each solution side-by-side across each consideration.

PART THREE

HARDWARE CONSIDERATIONS

Price

Cost vs. Performance

When it comes to individual device price, you'll want to balance between cost and performance. You can always find cheap devices, but remember you get what you pay for and that cost may come back to bite you when you need to pay for device replacements.

Cost vs. Feature Needs

You may end up paying for flagship consumer devices that have more horsepower and consumer-focused features than you actually need. It can be difficult to find a consumer device that provides the performance, security, and lifecycle - without making you pay for more than your use case requires.

Upfront / R&D Costs

There can be high upfront or R&D costs associated with going a more custom route. While it can be beneficial to get a completely custom device, it may require more capital than desired.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
PRICE	✓ High cost or low cost options available at different performance levels	✓ Competitive per unit prices	✓ Competitive per unit prices	
	✕ Can overpay for unneeded features	✓ Pay for the specs you need	● Devices are enterprise focused, so less focus on new consumer features	
	✓ No upfront R&D investment required	● Large upfront R&D investment	● Occasional limited upfront R&D investment required	

Lifecycle

End of Life

Device lifecycle is a huge thing to consider. Having devices go end-of-life can create major pain points. At the very least, you need to spend time retesting and revalidating that your app works on new hardware. In more drastic scenarios, you may need to resubmit to regulatory bodies like the FDA.

Next Gen Visibility

The degree to which end-of-life scenarios impact your business is tied to how drastic the hardware/software changes to the next generation device is. Changes range from small internal or component improvements, to completely revamped form factors.

Quick Tips

If you're going straight to China or building custom, you'll want to pay attention to component trends - specifically screen size. The further away you get from mainstream consumer devices, the harder and more expensive it will be to continue manufacturing devices to those specs.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
LIFECYCLE	✕ Avg. 9 - 18 month lifecycle	● Variable lifecycle, must be closely managed	✓ Enterprise lifecycle	
	✕ No control or visibility into upcoming hardware changes	✓ Ability to define next-gen hardware specs	✓ Transparent hardware roadmap	

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
CONNECTIVITY	● Multiple SKUs available for global coverage	✕ Must design from the ground up with global connectivity in mind	✓ Single SKUs available for global coverage

Connectivity

Optimizing Global Coverage

If you plan to utilize cellular data, and are also deploying devices globally, you'll want to research how many SKUs you'll need to support the countries you're deployed in. The more SKUs you need to support, the more challenging your operations will become.

Quick Tips

Your device will almost certainly need some sort of connectivity - whether it's wifi, cellular, Bluetooth, NFC, etc. Even if you think you'll only need wifi, our recommendation is to always go with a device that has cellular connectivity. This is especially true in the medical field, where the collection of data is critical. A device with cellular connectivity will cost more, but it can have huge payoffs in terms of risk mitigation.

Hardware Customizability

Customization Value

Consider how valuable it is for your specific use case to customize the device form factor. In remote monitoring scenarios, for example, having a small device that can be easily carried around can be a good differentiator. Or having a device that can leverage power-over-ethernet can lead to huge power and infrastructure cost savings. In other cases, your differentiation may be in the software, and a simple off-the-shelf (OTS) device will work great.

Required Hardware Expertise

Keep in mind that the more custom you go, the more hardware expertise you'll need on your team. While you can outsource design/development to a third party, in most cases we recommend having someone with hardware knowledge in-house.

Stories From the Field

Simple hardware features can often have unexpected downstream impacts - in a positive way. A patient engagement provider included the ability to power a device via ethernet. This resulted in annual cost savings on power that was enough to cover the cost of the 22" tablet. Selling into a hospital becomes much easier when power savings alone can cover the cost of the hardware.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
HARDWARE CUSTOMIZABILITY	✕ No control over hardware specs ✓ Limited hardware expertise required	✓ Full control over hardware specs ✕ Specialized hardware knowledge required (internal or outsourced)	● Base device customization options (limited) ✓ Accessory development services for use-case versatility (e.g. POS case) ✓ Limited hardware expertise required	

Quick Tips

One alternative option is to invest in building accessories that can be used with a custom or COTS device. This allows you to morph a device to your specific use case, without having to build something new from the ground up (e.g. think how Square used an iPad + a custom point-of-sale stand).

PART FOUR

OPERATING SYSTEM / DEVICE MANAGEMENT CONSIDERATIONS

OS Customizability

Customization Ability

Being able to customize the OS can add huge value - especially for single-use devices in the healthcare and medical space. On the surface level, it allows you to white label the experience and gives you control over the UI/ UX beyond just your app. At a deeper level, however, it lets you truly lock down the device into a single use mode. This is especially valuable if you have an elderly user base that may inadvertently escape the app, trigger an unwanted setting, or get the device into an insecure state.

OS Expertise

When going custom, consider the engineering expertise needed to build and support an OS. Building a custom OS can take months of specialized development work, you will likely want at least two to three full-time OS/ Firmware engineers on staff for development and continued support.

Stories From the Field

A company developing a defibrillator controlled by a tablet needed a completely locked down operating system and resorted to building their own Android OS. This route does provide the desired locked down experience - but also resulted in burning thousands of dollars a month on development. If you want a custom OS, consider solutions that provide the tools to build an OS in a few minutes

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
OS CUSTOMIZABILITY		✕ Must use the OEM OS or find unlocked device to support a custom OS	✕ Must build in-house firmware team to build OS or leverage unreliable OS from manufacturer	✓ Can build, customize, and control the OS without touching source

OS Standardization

Standardization Across Fleet

Minimizing the different OS versions deployed across your fleet can significantly streamline your engineering efforts. The more OS variants you have to account for, the more testing and validation you need. This is especially important in healthcare, where changing the OS may require review from regulatory bodies, or where the testing processes are more thorough and resource intensive.

Stories From the Field

Keep a close eye on devices you're purchasing. Even if you purchase the same hardware SKU just a few months apart, they may come with different OS versions on them. A company in the clinical trial space had set up a script to simulate inputs on the device to automate the device setup process. When they received their latest devices, they had a different OS version which didn't support the scripts, and had to manually provision hundreds of devices.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
OS STANDARDIZATION	✕ Unable to control or standardize OS across device fleet	● Can standardize OS, but no secure, out-of-the-box way to update remotely	✓ Full control to standardize and continually update the OS on your terms

Security

Security Patch Timing

There are regular security patches released for every major OS. However, taking the patch and releasing an update is in the hands of each individual OEM. In other cases, these can be released right away, but in some instances it can take weeks, months, or it may never be released at all.

Customization/Control vs. Security

To get an enhanced level of control and customizability over the device, some companies decide to root or flash a custom OS after manufacturing. This is a good way to get the granular control you want in single-use devices, but is also a huge security risk and leaves your devices wide open to malicious actors.

Quick Tips

If you're dealing with any sort of patient data or proprietary information, it's critical that you have devices that have the latest security patches, have a locked bootloader, and are not rooted. Missing on any one of these can leave you wide open for attacks. You're best bet is to go with a flagship consumer device (not low end hardware), or work with a provider that has the infrastructure in place to release updates as needed.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
SECURITY	✕ Reliant on OEMs and carriers for security updates	● Must integrate Android security updates in-house and find a way to deploy		✓ Security updates available as needed within days of release
	✕ Granular UX control often means rooting the device and opening up security vulnerabilities	✓ Device rooting not necessary for control		✓ Granular control through SDKs without needing to root the device
	✕ Can unlock boot-loader to flash third-party OS onto device	✓ OS flashed during manufacturing, does not need bootloader unlocked		✓ Custom OS available without unlocking the bootloader

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
UPDATES	✓ Control over app version on devices through MDM/EMM	✕ Must build app and OS update infrastructure in-house	✓ Full control over app updates	
	✕ Limited control over OEM OS updates	● No unwated updates pushed by OEM	✓ Full control over OS updates	

Quick Tips

Be careful when blocking OS updates using an MDM or EMM. In some instances, you may only be able to delay OS updates, not block them completely. This gives you a short term break to make sure your app works on new OS versions, but can still lead to unexpected fire drills if devices start receiving the updates.

Updates

App Updates on Your Terms

Ensuring you have the latest version of your app deployed across your fleet lowers support cost and improves the overall UX. However, in the medical space you need to be able to determine when and how updates get deployed. For example, you wouldn't want app updates interrupting a critical heart-rate measurement or monitoring event.

Blocking Unwanted Updates

You also want to make sure no updates get deployed to your devices unexpectedly. Specifically, an OEM (e.g. Apple, Samsung, etc.) may push down a new OS version that breaks your app, interrupts end-user, or gets the device out of a single-app mode. Blocking updates can be just as important as pushing updates.

PART FIVE

OPERATIONAL CONSIDERATIONS

Provisioning

Individual Device Setup

A lot goes into setting up a single-use device. You need to load the proper apps, push the correct settings, insert SIMS, create accounts, etc. The more you need to change on the device from it's stock setting (e.g. adding an MDM, flashing a new OS, etc.) the more time consuming and manual it becomes. It also opens up more room for error, which can have unexpected downstream ramifications.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
PROVISIONING	✕ Manual time-consuming setup or 3rd Party service required	✓ Provisioned and kitted by the manufacturer	✓ Truly zero-touch provisioning tools ✓ Services to off-load all provisioning and kitting if needed	

Quick Tips

Working directly with the manufacturer is the most streamlined way to go for a fast, consistent setup process. This is easiest when you are sourcing direct from the manufacturer or using a mobile IaaS solution, but in some cases you can work with consumer brands to get devices sent to you pre-provisioned.

Distribution

In-House vs. Third Party

You will want someone who knows what they are doing when you have to deal with shipping physical goods, especially globally. Not investing in this can lead to huge hidden costs and can be the biggest roadblock to scaling effectively. This may require you to work with a third party logistics shop, or you may want to consider building out an in-house operations team.

✕ Negative Impact ✓ Positive Impact ● Neutral Impact

	Infrastructure Component	Consumer	DIY (do it yourself)	Mobile Infrastruture-as-a-Service
DISTRIBUTRION	✕ Must setup in-house operations team or work with third party	✕ Must setup in-house operations team or work with third party	✓ Option to handle distribution in-house or use Mason distribution services	

Conclusion

The number of ways that single-use mobile devices can be leveraged in the healthcare space is endless - but regardless of how it's being used, having a solid mobile infrastructure solution that meets the needs of your business is critically important. You can check out our full side-by-side comparison chart below, but at a high-level, here are the big takeaways from each option:

- **Consumer:** A great option for startups, companies that are highly price-sensitive when it comes to hardware, or businesses wanting to buy on-demand in small quantities. You biggest challenges will be related to lifecycle, reliability, and scalability. If you anticipate hardware changes or potential OS updates creating headaches, or you plan to scale past 1K+ devices, you may want to consider other options.

- **DIY:** If you are wanting to have a unique, proprietary hardware product and can build the team to make this happen, the DIY route should definitely considered. However, this is an all-or-nothing proposition - and you will want to make sure you have a full hardware and firmware team built out to ensure you can manage the supply chain and have the proper infrastructure to support remote OS, app, and security updates.

- **Mobile IaaS:** Because mobile IaaS was built specifically for this purpose, it's a great fit for companies at all stages and across different use cases. That being said, you may run into some speed bumps if you anticipate needing extremely custom hardware or if you are looking for the lowest cost hardware.

Hopefully this guide gave you a good overview of the mobile infrastructure landscape and provided a good framework for what to consider when picking your solution. If you have any questions about any of the items discussed above, feel free to reach out to **alex@bymason.com** and I'd be happy to help.

✕ Negative Impact | ✓ Positive Impact | ● Neutral Impact

	Consumer	DIY (do it yourself)	Mobile Infrastructure-as-a-Service
Hardware Considerations			
Price	✕ Can overpay for unneeded features ✓ No upfront R&D investment required	✓ Competitive per unit prices ✓ Pay for the specs you need ✕ Large upfront R&D investment	✓ Competitive per unit prices ● Devices are enterprise focused, so less focus on new consumer features ● Occasional limited upfront R&D investment required
Lifecycle	✕ Avg. 9 - 18 month lifecycle ✕ No control or visibility into upcoming hardware changes	● Variable lifecycle, must be closely managed ✓ Ability to define next-gen hardware specs	✓ Enterprise lifecycle ✓ Transparent hardware roadmap
Connectivity	✓ Single SKUs available for global coverage	✕ Must design from the ground up with global connectivity in mind	✓ Single SKUs available for global coverage
Hardware Customizability	✕ No control over hardware specs	✓ Full control over hardware specs ✕ Specialized hardware knowledge required (internal or outsourced)	● Base device customization options (limited) ✓ Accessory development services for use-case versatility (e.g. POS case) ✓ Limited hardware expertise required
OS / Device Management Considerations			
OS Customization	✕ Must use the OEM OS or find unlocked device to support a custom OS	✕ Must build in-house firmware team to build OS or leverage unreliable OS from manufacturer	✓ Can build, customize, and control the OS without touching source Full control to standardize and continually update the OS on your terms
OS Standardization	✕ Unable to control or standardize OS across device fleet	● Can standardize OS, but no secure, out-of-the-box way to update remotely	✓ Full control to standardize and continually update the OS on your terms
Security	✕ Reliant on OEMs and carriers for security updates ✕ Granular UX control often means rooting the device and opening up security vulnerabilities ✕ Can unlock boot-loader to flash third-party OS onto device	✕ Must integrate Android security updates in-house and find a way to deploy ✓ Device rooting not necessary for control ✓ OS flashed during manufacturing, does not need bootloader unlocked	✓ Security updates available as needed within days of release ✓ Granular control through SDKs without needing to root the device ✓ Custom OS available without unlocking the bootloader
Updates	✓ Control over app version on devices through MDM/EMM ✕ Limited control over OEM OS updates	✕ Must build app and OS update infrastructure in-house	✓ Full control over app updates ✓ Full control over OS updates
Operational Considerations			
Provisioning	✕ Manual time-consuming setup or 3rd Party service required	✓ Provisioned and kitted by the manufacturer	✓ Truly zero-touch provisioning tools ✓ Services to off-load all provisioning and kitting if needed
Distribution	✕ Must setup in-house operations team or work with third party	✕ Must setup in-house operations team or work with third party	✓ Option to handle distribution in-house or use Mason distribution services