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Developer trying to code network slicing for real

Developer Problems with Network Slicing



Geoff Hollingworth

Not a normal CMO. Rakuten Whisperer. Rakuten Symphony



April 25, 2024

I spent the weekend trying to code network slicing. Here is what I understood, realized, and learned.

Background

There are some very aggressive claims about the value of advanced capabilities in 5G that can be exposed and monetized by external developers.

- McKinsey claims network APIs have the potential to unlock between 100 - 300 billion dollars indirectly and between 10 - 30 billion dollars directly from APIs [ref].
- Kearney claims that 95% of developers are prioritizing 5G APIs and enhanced connectivity in their apps [ref].

One large part of this conversation is network slicing. As a developer, I decided to place myself in the shoes of one of the above 95% of developers, to try and understand what is required for me to develop a working solution. The article is designed as a list of problems that need to be overcome. It primarily focuses on the challenges developing network slicing for the smartphone, public mobile network market, where 95% of the developers work.

To set the stage network slicing only works on 5G mobile networks.

Problem 1: Multi-Network Reality

As a developer, I don't know what network I am connecting to, and I cannot choose a different network.

For mass market deployments (95% of developers) we are speaking about developers who are focused on deploying to smartphones. At any point in time, a smartphone can be connected to one of the following

1. Home Wi-Fi
2. Public Wi-Fi
3. Corporate Wi-Fi
4. VPN Network
5. Satellite Network
6. Cellular Roaming Network
7. Private 4G Network
8. Private 5G Network
9. Home 5G Network

Wi-Fi networks are where 80% of traffic happens today. As a developer implementing features and use cases, the business case for when that feature is available is limited to the last two network scenarios - either a private 5G network or my home 5G network.

Private 5G networks could make sense, the devices could be bespoke and connectivity be guaranteed to be 5G since the network is dedicated and designed for this. This is a niche specialized development and developer ecosystem.

For the sake of this article, let us follow the mass market (95% of developers) who are developing for smartphones where users are sometimes connected to their home 5G network, and we are going to implement the connectivity boost button in our app - to allow prioritized (fast) download speeds for 5 minutes, for \$5.

Problem 2: Staying 5G connected

If somebody pays for a service that only works on the home 5G network, the application needs to guarantee the device is on the 5G network. The common experience of all Gs but especially 5G is that it seamlessly drops to alternative Gs as the device moves and the network conditions change.

I have an iPhone so will follow iOS. I ask the question:

in an iPhone app can I force the connectivity to be 5G?

And the answer I receive back.

"It's important to note that:

- *Forcing 5G may not always be possible if the 5G network is not available in your area or if the signal is weak.*
- *Selecting 5G On may result in faster speeds but could also drain your battery faster.*
- *There is no direct API to programmatically force 5G connectivity in an iOS app"*

Is it possible to force a connection to be 5G? The answer is no.

Problem 3: Establishing a network slice

What are the APIs I can call to establish a connection to a network slice, assuming I am connected to a 5G network and I am not going to lose that connection?

The one carrier that I can find supporting developers to their credit is T-Mobile USA.

The screenshot shows a landing page for 'NETWORK SLICING'. At the top, there's a header with the T-Mobile logo and 'DEVEDGE'. Below the header, a main section is titled 'First U.S. carrier to enable slicing for developers'. It contains text about T-Mobile's 5G capabilities and how slicing improves consistency. To the right, a sidebar is titled 'Leverage the benefits of 5G' with a sub-section about the beta program. A pink button at the bottom right of the sidebar says 'Apply for slicing beta'.

T-Mobile USA Dev Edge

They offer a proof of concept video slice as part of their dev edge developer portal.

The screenshot shows the 'Overview' page for 'Network slicing'. The left sidebar has a 'Documentation' section with 'Fundamentals' expanded, showing 'Network slicing' with 'Overview' selected. The main content area has a heading 'Overview' and a 'ON THIS PAGE:' section with links to 'Video calling slice beta' and 'Support'. A note at the bottom explains what Network Slicing is. A 'Feedback' button is located in the bottom right corner.

T-Mobile Dev Edge Program - Network Slicing

This further limits the definition of where network slicing works. I have to be a T-Mobile subscriber on my home T-Mobile 5G Network.

AND my handset must support it. The supporting devices are as follows

Apple	Google
<ul style="list-style-type: none"> • Hardware: <ul style="list-style-type: none"> • iPhone 14 (any model) • iPhone 15 (any model) • Software: iOS 17 	<ul style="list-style-type: none"> • Pixel 6 (Model: GB7N6), SW version: UQ1A.231205.015, SVN 73 • Pixel 6 Pro (Model: G8V0U), SW version: UQ1A.231205.015, SVN 73 • Pixel 6a 5G (Model: GX7AS), SW version: UQ1A.231205.015, SVN 52 • Pixel 7 (Model: GVU6C), SW version: UQ1A.231205.015, SVN 37 • Pixel 7 Pro (Model: GE2AE), SW version: UQ1A.231205.015, SVN 37 • Pixel 7a (Model: GWKK3), SW version: UQ1A.231205.015, SVN 22 • Pixel 7a Foldable (Model: G9FPL), SW version: UQ1A.231205.015, SVN 30 • Pixel 8 (Model: G9BOD), SW version: UQ1A.231205.015, SVN 6 • Pixel 8 Pro (Model: G1MNW), SW version: UQ1A.231205.015, SVN 6
<p>Samsung</p> <ul style="list-style-type: none"> • Hardware: <ul style="list-style-type: none"> • Samsung S23 • Firmware: S911USQU1AWH1 • SVN: 14 • Samsung S23+ • Samsung S23 Ultra <ul style="list-style-type: none"> • Firmware: S916USQU1AWH1 • SVN: 14 	<p>Motorola</p> <ul style="list-style-type: none"> • Hardware: <ul style="list-style-type: none"> • RAZR 2023 (Model: XT2321-3) • Software: Android 13
<ul style="list-style-type: none"> • Software: Android 13 	

Current list of T-Mobile devices supporting Network Slicing

AND my SIM must support it.

To utilize a beta video calling slice, a device must use a post-paid 5G SA SIM from T-Mobile. The physical SIM must have "R15 T" written on it, as shown in the image below.

If I can meet the above prerequisites I can code my Apple device as per below.

Step 3: Call the slice within your application code

Follow the steps below to call the network slice and route your app's network traffic through it:

Apple

1. Consult the Apple developer documentation for information on how to support network slicing on your app using **XCode**.
2. Using Xcode 15 beta 5, add Slicing Entitlement to your app. Set the category to **communication**.
3. Modify your application code related to initiating network connections. When opening communication channels, the app should initiate network connections using **Network Service Type** as **Voice** and/or **Video**.
4. See the [developer documentation](#) for instructions on how to open connections using the **Voice** and **Video** characteristics.

To verify that the connection to the network slice is being successfully established:

1. Note the device's IP address before requesting the slice.
2. Note the IP address of the application calling the slice after the request is made.
3. Compare the two IP addresses. If the slice has been successfully enabled, the IP addresses will be different.

T-Mobile instructions on how to code network slicing on an iOS device

FEEDBACK TO T-MOBILE: Give developers a sample app so they can quickly deploy on my device and see the network slice working.

The beta implementation in T-Mobile pre-defines a network slice and then manages configuration and access. The CAMARA API project has started doing Network Slicing API work, first meeting on Friday March 15th 2024

The screenshot shows the CAMARA Network Slice Booking API page. At the top, there's a navigation bar with links for Home, About, Sub Projects (A-H, I-Z), Working Groups, Events, Resources, and Contact. The main title is "Network Slice Booking". Below the title, there's a section titled "Scope" with a list of requirements. Under "Meetings", it says "Meetings will be held virtually. The first meeting will be on Friday, March 15th." At the bottom, there's a link to "CAMARA Network Slice Booking API".

Scope

- Service APIs for "Network Slice Booking" (see APIBacklog.md)
- It provides the customer with the ability to:
 - reserve, dynamically provisioning, query, dynamically delete a slice with customized SLA assurance capabilities, customized service duration, expected slice covered locations.
- Describe, develop, document and test the APIs (with 1-2 Telcos)
- Started: January 2024
- Location: virtually

Meetings

- Meetings will be held virtually. The first meeting will be on Friday, March 15th.

CAMARA Network Slice Booking API

Problem 4: Multi 5G network

I recently had the honor of meeting somebody responsible for implementing emergency networks in the USA. **If the purpose of network slicing is to guarantee performance then he serves as the perfect proxy for businesses' requirements.**

His fundamental business requirement is that he cannot depend on one network operator. If a natural disaster or an attack of some kind takes down one network, he has to make sure all emergency responders can still seamlessly communicate on any other network that is still working. He needs to have resiliency through redundancy. He also has to make sure their traffic is prioritized above other people's traffic.

In reality, telecom needs to understand this is true for any business and if we say differently, then we are not treating their business with the mission-critical respect they deserve.

Traditionally this was solved with common priority access configuration coordinated across all networks, between device configuration, subscription configuration, and network configuration. Because the networks were statically defined, once this configuration was in place, confidence was high the networks could cope with the game-played scenarios.

Now with highly programmable and dynamic networks, the static guarantees are gone. In theory the programmability should lead to better solutions since what disasters require is the ability to reconfigure infrastructure on the fly, to serve the immediate needs.

Network slicing seems to be the perfect center of design to be able to solve for this. However, network slices are not federated and there is no common ability to provision slices across operators. There are no common introspection capabilities to guarantee performance is as designed. There needs to be guarantees of security around the API orchestration (this is now not a simple SMS), and there must be proof that network slices once defined and secured are protected from other types of cyber attacks such as massive traffic denial of service on adjacent slices.

The disaster management requirements are the perfect proxy for all businesses needing guarantees of network performance. If telecom chooses to view them this way.

Problem 5: Multi-network, Multi-path

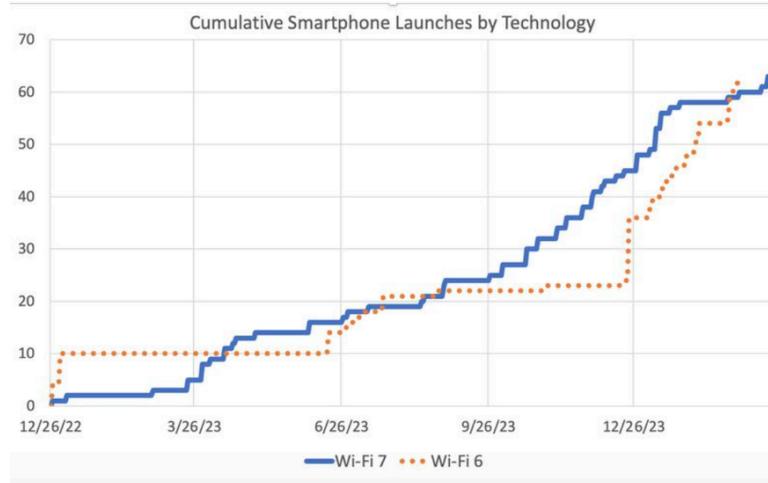
Network design is becoming increasingly multi-network design. 80% of traffic today is indoor and nomadic, and never on cellular, but rather Wi-Fi connected directly to fibre. [Gabriel Desjardins \[ref\]](#)



Gabriel Desjardins • 1st
Director, Wireless Connectivity Division at Broadcom
1mo •

...

Is Wi-Fi 7 really here? We are a little over two months since Wi-Fi 7 certification launched, and just over a year since the first devices were available. There are, by my count, 63 smartphones on the market, and at least 62 access points, though they are more difficult to track. What's interesting is to see how the rollout compares to Wi-Fi 6, which was Wi-Fi's fastest-ever technology upgrade. The rate of Wi-Fi 7 launches is roughly the same as it was for Wi-Fi 6 (though the volumes are not), and the average phone price and screen size are actually less than for Wi-Fi 6 at the same point (\$762/6.8" vs \$826/6.9"). So I would say Wi-Fi 7 is definitely here, and at a lower price point than 2020's new technology.



Credit: Gabriel Desjardins

Wi-Fi 7 capabilities and beyond are reaching parity with cellular networks, which should not be a surprise since they have started to adopt similar lower-level solutions. [\[Eran Dor\]](#)

Unprecedented Speeds and Bandwidth

Wi-Fi 7, or IEEE 802.11be, is set to deliver speeds that were once unimaginable for wireless technology. With theoretical maximum speeds up to 46 Gbps, it more than quadruples the peak speed of its predecessor, Wi-Fi 6. This surge in speed and bandwidth is achieved through more efficient use of the spectrum, including wider channels up to 320 MHz, and higher-order QAM (Quadrature Amplitude Modulation) of 4096-QAM. For the typical consumer that uses a Wi-Fi 7 router access point and a Wi-Fi 7 client device, this means smoother 4K/8K video streaming, faster downloads, and more responsive online gaming experiences. Further, the impact extends beyond entertainment, empowering remote work with seamless video conferencing and real-time collaboration, as if everyone were together in the same room.

Credit: Eran Dor

This is also reflected in the latest designs of the higher-level application layers of the stack.

I cannot recommend this article enough - "Lessons Learned from 20 Years of Cellular and Wi-Fi Integration" [ref], written by [Mark Grayson](#). Read it all but I want to pull out the last section for the context of this article.

The third lesson learned is to avoid thinking of situations where multiple accesses and multiple paths are available to devices as peculiar.

We are increasingly connected to multiple networks at any one time and the selection of which network to use is driven by a number of factors - performance to economic to security etc. I finish this section with the final two paragraphs of the document.

The device ecosystem is looking to meet the needs of their application providers by delivering frameworks that enable applications to configure how multiple paths should be employed, enabling applications developers to easily benefit from the HTTP3 connection migration capability.

The final lesson learned is that a single command-and-control approach to path-selection policy cannot accommodate all stakeholder requirements. And we should recognize that value is continuing to migrate towards the application; application loyalty is the new brand loyalty. So, the goal should be about how to best deliver those application experiences, and what hints and instrumentation can be exchanged between stakeholders to enable better decisions to be made.

Credit: Mark Grayson

How do we ensure network slicing integrates into this multi-path, multi-access reality?

Problems 6++: And for completeness

I add these just for completeness.

Net Neutrality

Are we even legally allowed to do network slicing? Can we do it wherever we want? Can we prioritize our own services over those of others?

Are there legal limitations?

Service Level Agreements (SLAs)

If I buy something that promises to deliver something, I want guarantees I am getting what I paid for. Service Level Agreements are the legal mechanism used to manage this. I have not seen any Network Slicing Service level agreements, either examples or commercially binding documents. I cannot see how an mobile network operator will deliver an SLA guaranteeing performance when they know their network is a shared resource that can never have universal geographical coverage. We know this to be true as consumers today whenever we enter a "not-spot" or our "call" drops.

Existing customer perception

I thought I was buying a highly performant service. Are you now telling me that I have to pay extra to get service that I can actually trust will work? That is not what your adverts have told me and I feel I need to find 5 like minded people and a lawyer... (a little USA humor there).

Conclusion

Look where this article has left us. For the mass market developer there is more chance in winning the lottery than having the above stars align with a real developer need, outcome or business that can scale today.

Developers are a business where the asset they have to spend is time. They must focus on developing code that has the maximum business impact with least amount of effort. The above shows that there are fundamental issues that will hinder any mass market update of network slicing in the broad developer, app, and smartphone community.

These can be potentially overcome with time, and focus on real developer needs. But my fear is the lack of real world attention being paid to what the developers really need and what will drive real developer and application success with network slicing. A lack of focus on what really can make sense and the hard work required to drive it to success with single mindedness. Instead we have more 5G washing and the hoping that 5G SA (which is another pre-requisite for network slicing) is riding in on the famous G named unicorn to save the day.

I don't see how developers can develop network slicing other than with private 5G network deployments. In that scenario, it appears network slicing is not a developer task but a network, device "priority access" configuration type task.

The 100-300 billion indirect API market and 10-30 billion direct API market must be coming from other types of APIs and network exposure.

If you are one of the 95% of developers who are prioritizing 5G APIs and enhanced connectivity in your apps, then can you please reach out and say what you are doing and how you intend to leverage them?

The state of network slicing today, after 10 years of discussion and design, is that network slicing a highly complicated, technically powerful concept, that has no realistic path to real world enterprise or developer engagement at mass market scale.

If we do not fix this then we will disappoint 95% of developers not please them.



Telecom with a hammer looking for a developer nail

Comments

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Rhett Sampson 1st Founder and CTO at GT Systems 1y ...

Geoff Hollingworth thanks for calling the elephant in the room. You hit the nail on the head: "network slices are not federated and there is no common ability to provision slices across operators." These are the EXACT conversations we are having with all operators not just 5G. We really need to talk! Check your LinkedIn DMs! And read this. It's ...more

Like · 5 | Reply · 7 replies

[See previous replies](#)

Atilla Horvat 1st Board Advisor | Head of Portfolio Strategy & Network Slicing | ... 1y ...

Rhett Sampson Yes, that is not 3GPP introduced end to end network slice. What you are building sounds like a mix of intra and inter PoP end to end connectivity models that might serve one or more end to end 3GPP slices. Definitely useful. ...more

Like · 1 | Reply

Adrian Singereanu 1st Member of Technical Staff at T-Mobile 1y ...

Well, there is currently a 'slice' for your voice calls since VoLTE was launched 10years ago, your voice travels over a dedicated path since then. Maybe you can use that example and check it against all the problems you listed. Not saying there is no complexity to implement slicing, but I would say it will be easier than doing voice with IM...more

Like · 2 | Reply · 6 replies

[See previous replies](#)

Atilla Horvat 1st Board Advisor | Head of Portfolio Strategy & Network ... (edited) 1y ...

(7) Developer Problems with Network Slicing | LinkedIn

Adrian Singereanu Of course you can today configure voice and other APN/DNN targeting services with different priority handling in RAN. Your mentioning of slice id and CQIs/5QIs here confuses but also clarifies a lot. You started this thread with the statement that your network has a slice for voice service more than 1! ...more

[Like](#) | [Reply](#)



Lars Nielsen · 1st
Solution Architect | Private 5G networks

1y ...

Great article Geoff, I also jumped into the Slicing game some weeks ago. My focus is on IoT devices, where there might be a bit more direct control over the device and you don't have as many problems as you are listing for the Smartphone mass market (as you also state in a comment). [...more](#)



Hands-on Experience with Network Slicing in 5G SA

Working with Network Slicing was not as easy as I expected. After all (as app developer) a Slice should just...

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[See previous replies](#)



Lars Nielsen · 1st
Solution Architect | Private 5G networks

1y ...

I have made an extreme simplification, the Train industry knows what they are doing, but it's very complex what they will do the next 10 years. Step one is not "no humans", but that is in the roadmap. The focus for them right now is to migrate from GSM-R to 5G (FRMCS), that itself is a big task :-)

[...more](#)

[Like](#) · 2 | [Reply](#)



Andrew Collinson · 1st
HI on Telco \$ | AI, APIs, CPaaS | MD, Connective Insight | CPaaS R...

1y ...

Great article thanks Geoff, really helps me understand this from a developer perspective. I am slightly worried about your weekends though! Great to see you last week...

[Like](#) · 3 | [Reply](#) · 3 replies

[See previous replies](#)



Atila Horvat · 1st
Board Advisor | Head of Portfolio Strategy & Network ...

(edited) 1y ...

Andrew Collinson Network slicing only makes sense from the developer perspective if we are discussing B2B and B2B2C apps (aka Enterprise apps).

[Like](#) · 1 | [Reply](#)



Anup Chatthoth · 1st
Director, Products | Network as a Service incl. Network APIs for Mobi...

1y ...

Hey **Geoff Hollingworth**, great call outs about our slicing offering to developers. There are definitely challenges around implementing smartphone apps with slicing support that works across multiple carriers. I personally think the intermediate need is around non smartphone apps to leverage slicing, which will most likely be si ...more

[Like](#) · 5 | [Reply](#) · 8 replies

[See previous replies](#)



Anup Chatthoth · 1st
Director, Products | Network as a Service incl. Network APIs fo...

1y ...

Geoff Hollingworth The answer is both. The current profile we support put the entire device on the slice(due to the fact that we are primarily targeting non smartphone devices), but I see a future where only a particular IP session is on a slice (especially to target smartphone use cases). [...more](#)

[Like](#) · 1 | [Reply](#)

(7) Developer Problems with Network Slicing | LinkedIn

**Paul Rhodes** 1st

Builder and Consultant on Open vRAN, Small Cell and EdgeAI Netwo...

1y ...

You should have ridden SWR while back in the UK, you would have seen that on the route down to the old Ericsson office in Guildford you would most frequently have had:

10: Home 2G (E) Network

...more

[Like](#) · 7 | [Reply](#) · 3 replies[See previous replies](#)**Adam Abdullah** MBA CMgr MCMI 1st

Clean Energy | Fuel Cell | Hydrogen | Telecom Network

1y ...

Same story for GWR from London to Brum. Network Anxiety!

[Like](#) · 2 | [Reply](#)**Vivek Parmar** 1st

Chief Business Officer | LinkedIn Top Voice | Telecom Media Technol...

1y ...

Absolutely wonderful article **Geoff**. Great insights and you hit the nail on the head. Federation of networks is a big problem and so is the variety of networks one connects to.

[Like](#) · 1 | [Reply](#) · 2 replies[See previous replies](#)**Vivek Parmar** 1st

Chief Business Officer | LinkedIn Top Voice | Telecom Media Te...

1y ...

Atila Horvat agree and you are right

[Like](#) · 1 | [Reply](#)**Henrik Pålsson** 1st

CEO Previsions, Senior Advisor, Thought Leader, Power Eng...

(edited) 1y ...

Personally I have seen slicing as an excellent tool for dynamic connectivity wholesale to "micro" MVNOs. To retail slicing directly to individual consumers feels to me like a dead end.

[Like](#) · 4 | [Reply](#) · 1 reply**Geoff Hollingworth** Author

Not a normal CMO. Rakuten Whisperer. Rakuten Symphony

1y ...

Henrik Pålsson I agree, I think the customers of "G capability" are we operators ourselves and we have to stop trying to apply them beyond our domains. They may allow us to offer different capabilities but we have to understand how and for what. ...more

[Like](#) · 1 | [Reply](#) | 57 impressions**Christos Tranoris** 1st

Researcher, Univ. of Patras, Greece

1y ...

Thanks for the great post. This is something that we would like to push further in the work we do with open source efforts at ETSI, with ETSI SDG OSL, offering simple low-cost solutions for private networks and utilizing further standardized APIs and the GSMA GST (as a common slicing model) for at least "roaming" the requested services by t ...more

[Like](#) · 3 | [Reply](#) · 1 reply**Geoff Hollingworth** Author

Not a normal CMO. Rakuten Whisperer. Rakuten Symphony

1y ...

thank you **Christos Tranoris**. What this thread has taught me is that there is some progress happening but there is very little consolidated education, or developer help in understanding how to make it work, when it makes sense to use. The T-Mobile QOD is good, USRP seems interesting. So I think if there was one t ...more

[Like](#) · 2 | [Reply](#) | 115 impressions**Atila Horvat** 1st

Board Advisor | Head of Portfolio Strategy & Network Slicing | Angel ...

1y ...

Geoff Hollingworth We should have a session on network slicing. I am not sure why we didn't have it.

Like · 2 | Reply · 1 reply



Geoff Hollingworth Author

1y ...

Not a normal CMO. Rakuten Whisperer. Rakuten Symphony

Atila Horvat enjoyed it. To summarize our discussion at the highest of the high level, there is a path and direction to navigate but we have to be realistic about the challenges and where we should start first, and what should be resolved next.

Much like **Anup Chathoth** above.

...more

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Provoking conversation and breaking taboos



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IoT Demands IPv6

Ali EL KSIMI

1



5G is coming!

Vahram Martirosyan

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