

Nokia SR 7730 SXR and FPcx

Disrupting and Innovation for Access and Aggregation

Authors: Grant Lenahan, Principal Analyst



Published by Appledore Research LLC • 44 Summer Street Dover, NH. 03820

Tel: +1 603 969 2125 • Email: info@appledorerg.com • www.appledorerresearch.com

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Publish date: 25-Sep-23

Cover image: Nokia

EXECUTIVE SUMMARY

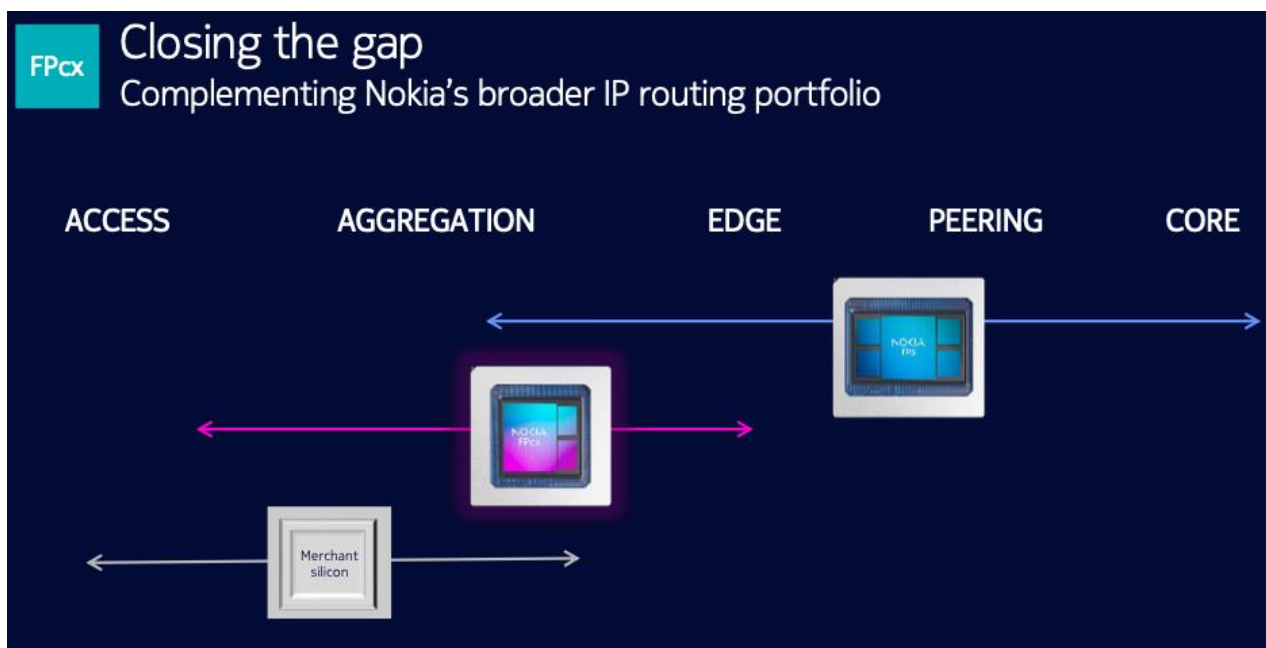
On Tuesday September 12th, coincident with the 2023 SRExperts Americas conference that focuses on all things Nokia IP and Optical, Nokia announced a major new IP product line and technology.

While we focus on Nokia's new announcements, we will treat this as a discussion of market needs and technology issues, including the complexity of automation, that applies to all router families and, in the messy real world, to multi-vendor environments. We also refer interested readers to our related market outlook on "specialty silicon in telecom networks", expected Q4 2023.

The technology is in the form of the first chip in a new family of fully programmable ("FP") Network Processing ASICs – the **FPcx**. Along with the FPcx, Nokia co-announced a router family to productize this chip, the **7730 SXR** router family. While not a new product announcement per se, they also explained that the 7730-SXR's Network OS ("NOS") would be a more mature version of their next generation NOS, **SR Linux** (as opposed to the highly mature and widely deployed SR OS). All three are actually part of a story about innovation, upgradeability, and flexibility. The FPcx will join the FP5 (announced/shipping in 2021) in Nokia's lineup.

The FPcx and 7730-SXR, as well as any future variants, target the Service Provider market, not datacenters, and specifically target the market niche outside the high-density core (home of the FP5), but beyond the truly thin last mile access. In essence, Nokia has decided that, based on the significant success of its FP4 and FP5 equipped Service Routers, and based on observed market demand for greater programmability and service innovation support, right-sizing and redesigning the FP technology specifically for access and aggregation filled an existing and emerging market need.

Figure 1: Market Segments and Coverage of Silicon SoCs



Courtesy: Nokia

The FPcx is slightly smaller (in overall throughput/capacity) compared to the FP5, but reasonably close. And yet, it also has a different architecture with some features that are tailored to access and aggregation – and one or two that are just plain improvements (more on that later). The “table stakes” specs – throughput, power per bit, performance, and programmability are, assuming all of Nokia’s data is accurate, class-leading across the industry. The 7730 SXR router chassis are sized to smaller environments as well, in 1U (“pizza box”) to 7U versions. All support pluggable optics.

Beyond the basics, SR’s and FP’s differentiator has always been straightforward: full throughput (no penalty), fully deterministic performance, even under difficult loads and with many “policies” to consider, and 100% programmability. In other words, a service provider can support many services/protocols, QoS, handle encryption, complex VPN routing, etc. – without sacrificing throughput or performance. And those losses (or, in the case of FP/SR, savings) translate to upfront cost savings, to power savings, to HVAC savings and to space savings – all of which result in saving more money. In theory the FPcx architecture and performance envelope removes the barriers to service innovation, security/encryption, DDoS and myriad other tasks that were cost prohibitive with DPI. And with the cx and 7730 SXR variants, this capability has migrated out into the aggregation and feeder plant where it can operate on streams earlier.

OVERVIEW: WHY PROGRAMMABLE ROUTING?

In order to simplify this discussion, we will temporarily look at things in “black and white”, and ignore those complex shades of gray that exist in the real world. Routers can be built with a library of functions, protocol support, service support (T1 emulation, anyone?), QoS, security features etc. And they will work well so long as you don’t need to change or add to any of those¹. Or, while many such functions may be built into the library, routers can be dynamically programmable – with the ability to modify rules and patterns to match, add them, and write arbitrary actions, like “drop anything that matches X”, where X is a known bad actor or action.

The market constantly evolves, with protocol updates, new services, and new demands. One of the most important emerging areas is security – hardware-based encryption, filtering, DDoS mitigation, and many others. Service Providers are also working to both meet customers’ sometimes unique network demands, and to offer new services – either to provide a competitive advantage (higher market share), or as premium, revenue generating, add-on services.

With much discussion of slices and differentiated services (for customers), this trend will surely grow. But just as important are the unknown opportunities and needs that will surely arise. Being ready to dynamically and (fairly) easily add such capabilities is likely to become a key weapon of market leading CSPs.

¹ In reality upgrades are made, but these too are in effect common maintenance releases, periodic, and typically monolithic.

Many services have been possible, and programmable, for years via dedicated appliances and DPI. Yet the high cost economics of DPI has resulted in it being reserved for the highest value services, particularly in mobile. Many routers are programmable – some more fully and more completely than others, but to the best of our knowledge, none claim to maintain rate and deterministic packet performance regardless of the number of programmed entries or the volume of effected data (up to 100%). For lightly programmed networks this may not be an issue, but as the number of matches and rules in micro-code grows, most routers deployed today will suffer increasing throughput degradation and packet loss.

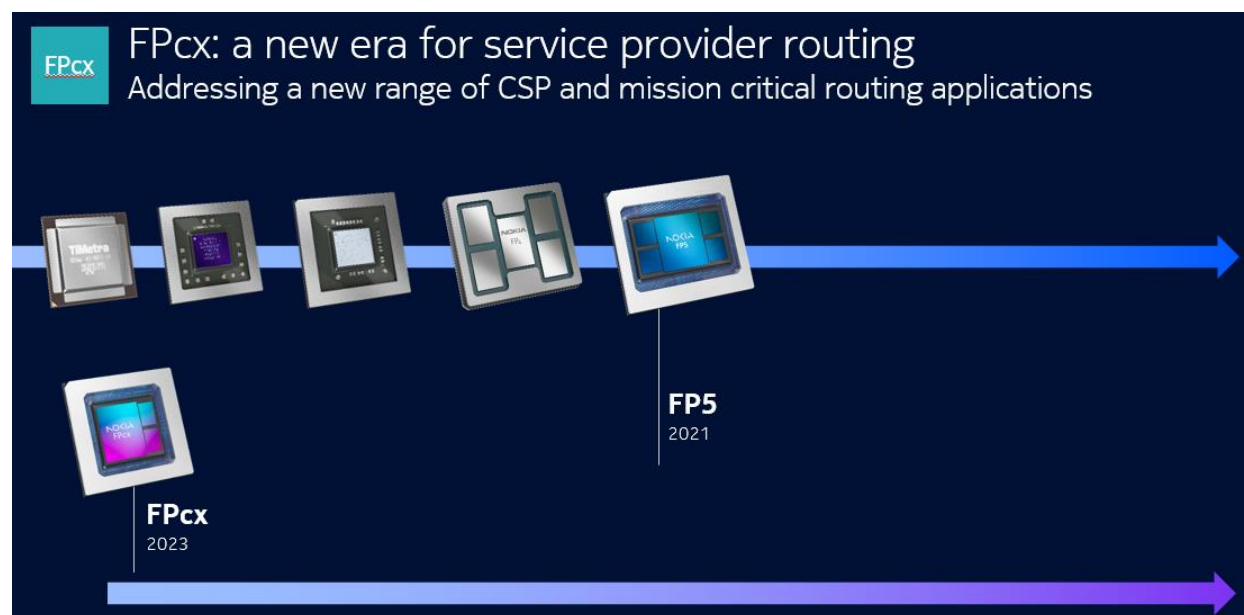
So, the big questions in every service provider's mind must be “how much programming do I plan to do?”, “how many changes must I push to maintain my network and a mix of legacy and emerging services and protocols?” and “how much do I want to innovate?”. It's not clear there is one right answer, but on the other hand, if the cost is minimal, having such flexibility is terrific insurance.

ENTER FPCX AND 7730 SXR

Nokia's announcement covered the chips (FPcx) routers (7730 SXR family) and its associated NOS (SR Linux, with enhancements). That said, the basic capabilities are enabled by the chips, so we will focus on them. The routers inherit these capabilities in a practical deployment vehicle – and the basic chassis is already familiar to CSPs across the globe as the 7730 IXR series.

The FPcx is part of the FP family which began in 2003 with the original FP, and not long ago birthed the FP5 (the current Nokia FP flagship). It would be easy to view FPcx as the latest (FP6?) or the slightly lower throughput as a hobbled FP5 – an “FP4.7” if you will, but neither is accurate. FPcx is in fact a clean sheet design using the FP technology, with innovations and tweaks of its own. Like the FP chip decades ago, it is the prototype for a new family/line.

Figure 2: Nokia's FP Family Evolution



Courtesy: Nokia

The FPcx chip has a throughput that is about 85% that of the FP5 (5Tbps) and, like the FP5, maintains that regardless of the programming load put on it. Among the most impressive (and sales driving) use cases for FP5 has been DDoS mitigation, at the edge, at line rate, with no degradation and no need to back-haul to a scrubbing center. We covered this approach to DDoS [here](#), including its economics and some operational benefits.

Power is another critical factor in cost, practicality and corporate responsibility, and there again the FPcx not only pays no penalty, but, again according to published Nokia specs (no, I can't verify them) leads the market with ~ 0.1W/g. The 7730 SXR can also be equipped with 400ZR and/or ZR+ coherent optical plugs – and this is important – can remain safely cool with 100% fill. This thermal hat trick draws on the same cooling and manufacturing technology Nokia introduced with the FP5 and 7750 SR series.

Fully Programmable...and Scalable Performance with complex programming

Despite the fact that FP stands for “FlexPath”, it could just as well mean full programmability, both literally as a name, and figuratively as a differentiator that Nokia hangs its reputation on. A service router, any router really, operates by looking at incoming traffic, classifying it by header tags or through deeper inspection, and then handling it according to existing rules. These rules might be relatively fixed, or might be easily programmable. It is essentially a policy enforcement point (PCEF), and the programmed rules, stored as the router's microcode, are the policies.

Programmability comes down to loading services into routing chips' real-time instruction memory. The FPcx chip effects services (which might be protocol implementations, or service conditional routing or queue selection, or ...) by having large tables of patterns and rules to follow.

All routers do this. The simplest routers, based on merchant silicon, typically have no programmability or very little. The downside is minimal innovation is possible, and upgrades mean a new NOS. The upside is simplicity, high raw throughput, and low cost. On many programmable routers, competitors/peers to the SR series, performance falls as the number of rules increases, and as the number of lookups (complexity and fraction of total traffic being handled by complex rules) increases. Some of this depends on how quickly patterns can be matched and associated rules followed. FP-equipped service routers claim to be completely independent of both – allowing more upgrades, more rules, and more traffic to follow more rules.

Rules/micro-code are maintained in ultra-fast memory – SRAM (static RAM) which introduces no lookup/action delay regardless of the number of entries, and consequently, packet forwarding performance remains deterministic and at rate – regardless. Not all chips have this characteristic, often using slower memory types which slow down as tables grow. As noted above, on FPcx these SRAM instructions stores/sets are shared by clusters of cores – there are 8 clusters – and may be programmed independently.

Cluster Independence and in-service upgrades

So far FPcx really does sound like a scaled down FP5, but here's where the cx differs in a good way. Above we noted that it is arranged into 8 clusters of cores, and each core has its own micro-code memory and may operate independently of the other 7. First of all, in terms of offering different services sets, is an advantage on its own. But there is another advantage that comes partly from the FPcx, partly from the programmability of the FPcx and the router itself, and partly from the latest version of SR Linux. The microcode in one cluster may be upgraded, while the rest of the router operates normally – allowing, in most situations, in-service programming without impact on customers and traffic.

On the surface, this is an important feature. But if you consider what it means for innovation flexibility, the speed with which innovations, patches, and upgrades may be rolled out, its long-term importance becomes larger. Think of it as CI/CD for micro-code. SR Linux is jointly responsible for this since it must handle these tasks. And according to Nokia, SR Linux is 100% programmable (and model-driven, which Appledore readers know we approve of, strongly). In this respect, SR Linux is ahead of even SR OS and Nokia claims it is the most fully programmable router OS on the market (at least among major vendors). Going forward, for the record, there will be one development stream that flows to SR OS, then compiled for SR Linux and is placed in gits for wide dissemination.

PART OF AN AUTOMATION ECOSYSTEM

There is an **unspoken assumption** underlying both our discussion, and Nokia's strategy for FP and SXR: **innovation and continuous upgrades and feature additions/changes is feasible and will occur**. The present reality is mixed, but it is safe to say that existing, largely manual, operations place a significant limitation on such practices. This is but one pointed illustration of the operational sclerosis that keeps telecom from moving as quickly as it needs to. And it is one of the root drivers of automation (along with increasing technological complexity, and market demand for on-demand services and changes) – Appledore's core area of coverage.

Fortunately, FPcx and 7730 SXR (and all the FPs and service routers from Nokia) **are part of a larger internal effort and growing ecosystem** that is **intended to move operations from manual to automated**, making such innovation and constant micro-code changes feasible – and fast.

At its simplest, FPcx can accept and execute many micro-code rules, easily and quickly. SR Linux can implement the router-level management to make this happen locally on a 7730 SXR series router (or future analogs). **Network Services Platform (NSP)** is the IP/optical domain automaton software in which rules and configuration settings are created, and which acts as the configuration management system for SR Linux devices (and, in fact hundreds of others across the router world, including Juniper, Cisco and other routers, AND optics). We will focus on how NSP is evolving to automate the management of SR routers while pointing interested parties to our recent profile on NSP, done as part of an enormous survey of automation in the IP/Optical domains – it is [here](#).

Network Service Platform – Nokia’s Intent-Driven Domain Automation Systems for IP& Optical

NSP has several attributes that can effect automation. During the recent SReXperts event in fact, we saw major presentations on both intent-based router configuration, automated model-based (pre-approved standard configurations) automated configuration, and a forward-looking project to put guard rails on Generative AI to create configurations the **GenAI** (it even adapted to “surfer dude” slang on request, and, according to Nokia, got it right).

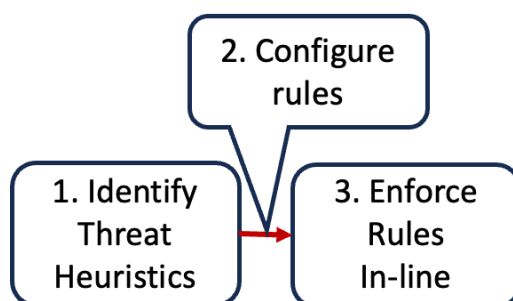
Regardless of the GenAI hero experiment, Nokia is pushing toward a future in which configurations and services are defined in terms of what you intend – and algorithms translate those into practical configurations, based on practical limitations such as router model and available inventory (no physical port? No service; go to Dispatch, sorry). Service providers need to consider these inter-meshing parts as a total system, looking not at how one flexible chip strains or breaks existing operations, but how automation may work synergistically with flexible network technology to save money, reduce errors and generate revenues – and we hope profits. In our survey of IP/optical domain automation in fact we saw similar directions and strategies – at various points of maturity – from many of the leading vendors.

ONE “KILLER APP”: DDOS MITIGATION

One of the apps that has driven FP recognition and adoption is DDoS mitigation. Nokia, via its **Deepfield** product, has for several years championed a different method of both identifying DDoS (based on a patented combination of source crawling and ML branded “**secure genome**”) and mitigating it (based on programmable service routers). In short, they champion a method that is constantly identifying both bad actors AND the resources, identified by address or heuristics, from which the threat is launched. This distinction is important because the largest volume of DDoS traffic now comes from Botnets, and those Botnets may be formed from unaware, innocent places (such as our own interconnected appliances). To drive the point home, Nokia noted about a year back that the USA had suddenly become a net exporter of DDoS, not because of our concentration of bad actor but because our IoT things were hijacked in large numbers, by bad actors, often elsewhere.

A simple system view of this policy-based mitigation system is as follows:

Figure 3: Logical Representation of In-line DDoS Mitigation with Programmable Rules



Source: Appledore Research

There are myriad advantages to mitigating DDoS as early as possible (peering points, edge or beyond...) and doing it in place – not by back-hauling terabytes of data² to a specialized location. This, however, demands programmable routers, and in fact programmable routers. Nokia emphasizes that it works with, and has in-service customers with, other programmable routers. But they also note that as the proportion of affected traffic rises, and the number of matches grows, many suffer throughput limitations often first detected as dropped packets. A quick internet search appears to confirm this. Nokia claims that it can perform in place, at rate mitigation of up to 100% of traffic, with no limits on rule numbers, without performance penalty.

APPLEDORE ANALYSIS

The telecom industry prefers to refer to itself as “communications service providers” – not as “network infrastructure providers”. In fact, for two decades many have lamented becoming “dumb pipes”. The rub is that truly delivering services, and making smart pipes, demands innovation, constant changes and upgrades. This in turn demands a **vastly more dynamic network that we are unafraid to touch** – in fact we must have methods that reduce risk while speeding network changes, and driving down ops costs – all at once.

On their own, 7730 SXR and FPCx cannot change this (nor can any of their competitors). But they can remove significant obstacles so long as other weak links in that chain (network automation software, router OSES, business policies and methods) also evolve.

In [these](#) reports, and the associated forecast, Appledore itemized **\$100B of new service revenues available globally to CSPs**. We are already seeing progress toward that goal, but not as fast as we would like, and no doubt with slower revenue growth than our CSP clients would like. And this is the rub. Conservative policies and slow change put artificial limits on our success. Paraphrasing JFK’s famous speech, we must shift from asking “why?” but rather “why not?” Or, “what do we need to put in place, and change, in order to be agile, efficient, innovative technology leaders?”

Many players in the industry are similarly pursuing goals of more capable and flexible routers, coupled to automation ecosystems. Most are at least beginning to implement intent-based (declarative) operations. Some are experimenting with analytics and ML that close repair or scaling loops. A few offer network and services on-demand, which nearly demands intent – and automation. So Nokia’s direction is not unique, but, if their claims are backed up in reality, their progress seems impressive. FPCx and its router embodiment, along with SR Linux, are designed with this world in mind. And NSP is designed as a critical supporting/controlling player.

Appledore have long stated that automated operations, while a little complex to switch to, greatly simplify operations in the long term. They reduce manual complexity and the need for expertise in the minutiae of router configurations. They nearly eliminate inevitable human errors. They allow mass deployment of upgrades, fixes and new variations. Once in place they can use the same

² And it’s worth noting, this is not cleaned data – good data is being mixed and sent on a journey too, which has implications. Think: latency and in some cases even packets out of order. Yuk.

methods and configurations to automatically heal networks and services, and proactively make changes so that customers may never be impacted.

These are goals worth investing in – in effort, time and human capital development – and painful institutional change. Nokia's message is one of change and innovation – with the hardware hopefully pulled along by the tide of change. These products aside, that is a valuable direction, and we believe these products can be a part of making that migration.

This line of reasoning applies to the entire FP line, and likely, some competitors³. The FPcx in particular, and its routers, bring this capability down in scale, and up in flexibility, by allowing in service upgrades (which encourage upgrades) and by allowing different micro-code in different "clusters". It brings this capability closer to the access (the true edge) and enables service, security and other rule-based functions closer to the service data's source.

Our discussion with service providers indicates strong interest, almost admiration, combined with some operational hesitancy. Larger organizations typically were more bullish on what they could, and would, do – while smaller operators were more cautious – most likely reflecting their smaller expertise pools and capacity for change. This, incidentally, mirrors the adoption of automation, analytics and AI in manufacturing globally and comes as no surprise. It also reinforces Appledore's position that suppliers need to package and de-risk next generation automated and agile ops, while also reinforcing our concern for the pace of change. Yet the silver lining even among the cautious was that they understood the opportunity and spoke well of the launch – even if they reserved judgement on pulling the trigger.

³ We have not seen the hard specs clearly from others, so this is really unconfirmed. Yet the trend is clear across major vendors – differences are likely in how far they have progressed.

Insight and analysis for telecom transformation.

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 Appledore Research

www.appledoreresearch.com

info@appledoreg.com

+1 603 969 2125

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