Nokia 5G signaling

Explore how a 5G Service Communications Proxy saves time and money

Contents

Getting 5G right

5G will benefit service providers by enabling many new profitable services through network capabilities such as higher bandwidth to mobile devices, ultra-low latency, and massive connectivity for Internet of Things (IoT). Recognizing this, communications service providers (CSPs) are transforming their networks, operations and businesses to seize this opportunity. The 5G core is at the heart of this transformation.

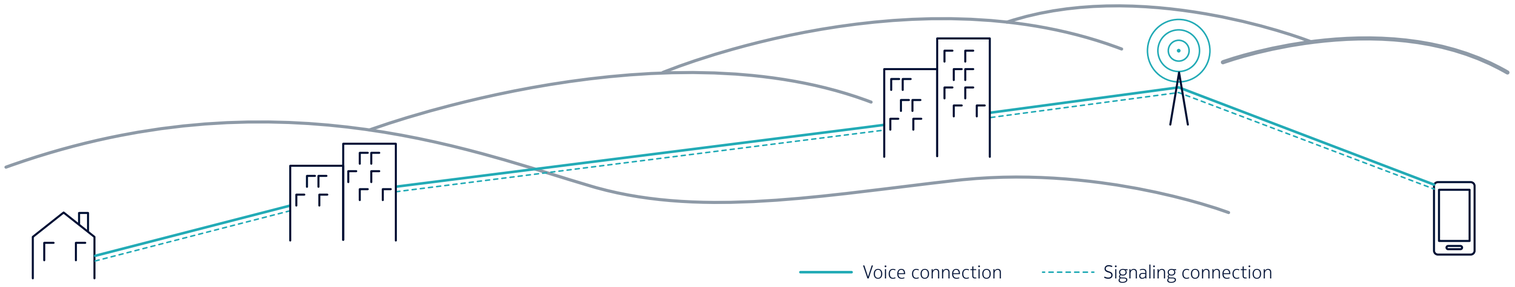
The 5G specification assumes that the core of the network will be deployed as cloud-native software. Network functions (NFs) that make up the 5G core are defined as small, modular components that communicate using control messages. This is organized around a service-based architecture that makes it easy for CSPs to add new network capabilities.

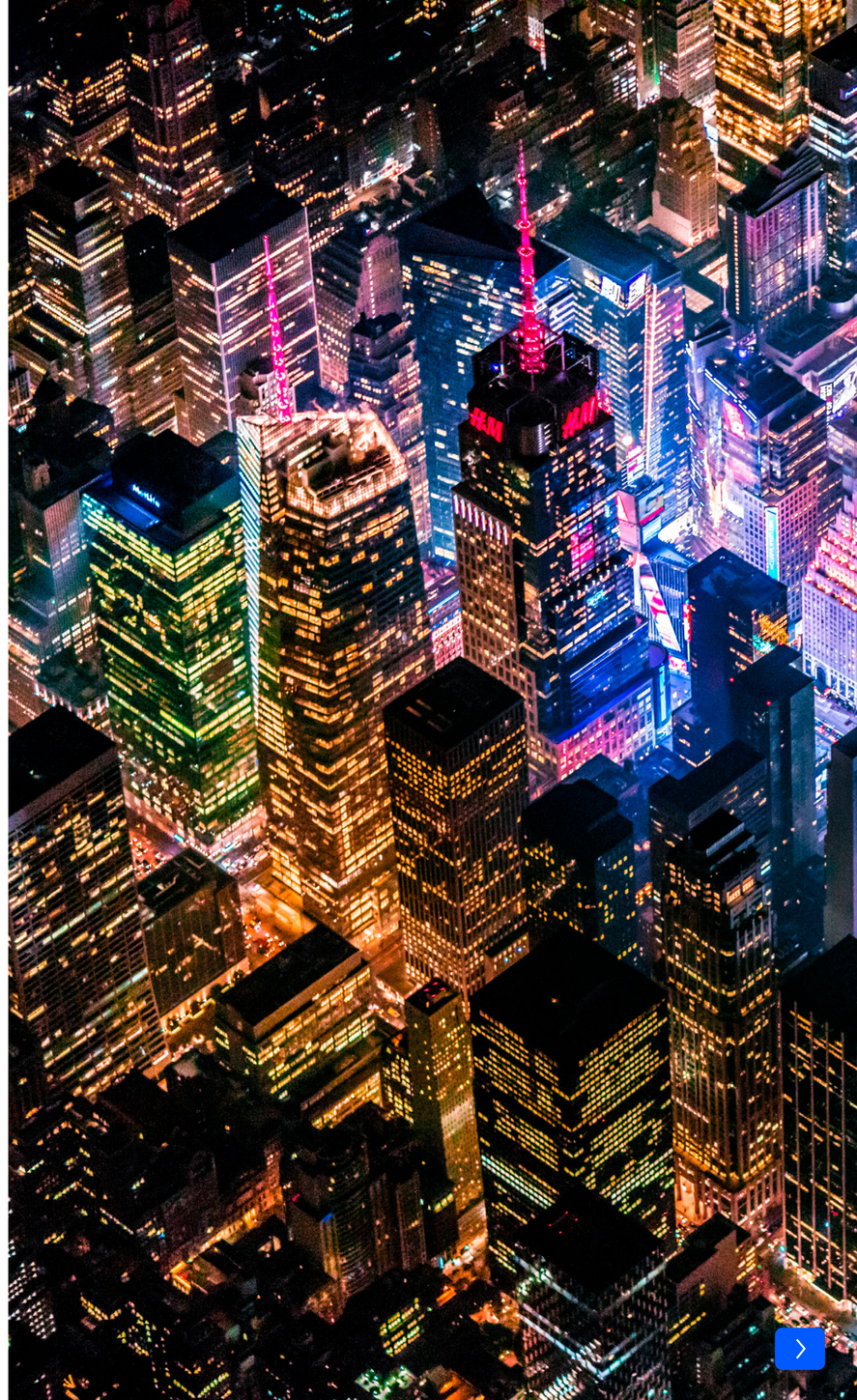
Efficient communication between NFs, called signaling, is vital to the proper operation of the network. Getting signaling right makes it easy to deploy 5G technology and services. Failing to put a signaling strategy in place will result in a network that is difficult to launch, unstable and, overall, more costly. Therefore, it is important for CSPs to plan for signaling from the very start of their 5G deployment.

What is signaling

Signaling originally referred to the messages sent between switching offices to help callers connect to the right destination phone. The signal information included the dialled number, calling number, billing information, and other basic information. At the time, a switching system was a monolithic product from a telecom vendor. But with the emergence of the internet and the cloud, the design of these systems slowly evolved to take advantage of these emerging technologies.

Switching systems were redesigned into the form of modular network elements that provided specific, well-defined functions often from different vendors. The industry standardized the functions and also the communications between them, with architecture and protocol specifications based on IT technology. With cloud technology, these systems were further decomposed into network functions, implemented as software modules in micro-services on a cloud infrastructure. Signaling evolved from inter-office communication to becoming a critical component of how the NFs coordinate the function of delivering services to consumers and enterprises.





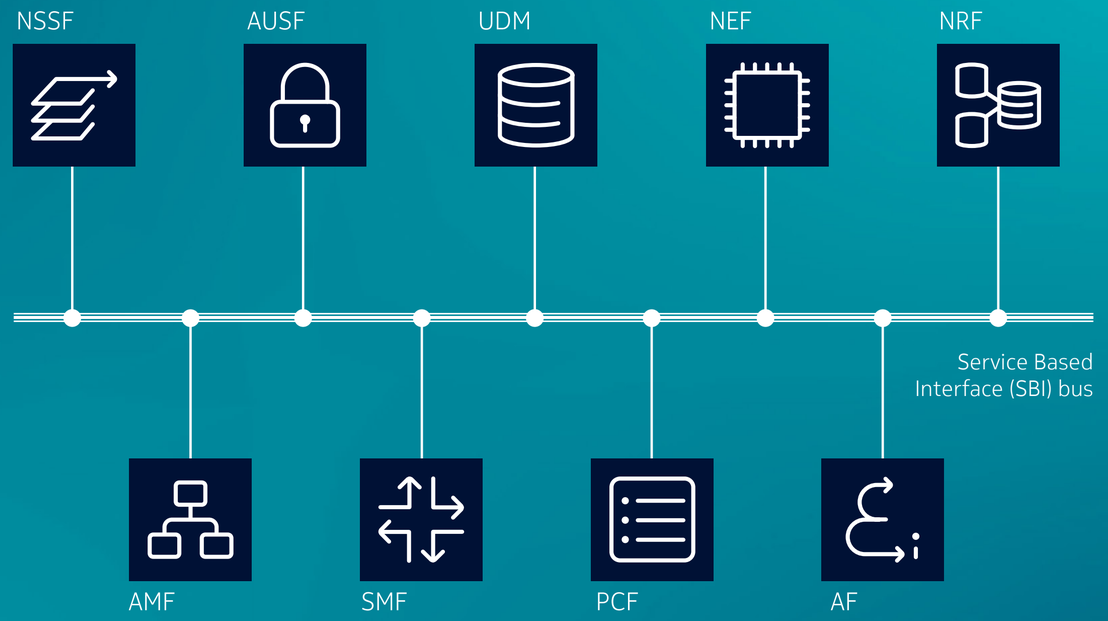
Today, the signaling between NFs is responsible for database lookups, service requests, acquisition of network resources, and many other internal functions for the 5G core. Signaling is the nervous system of the network, providing all communication and coordination in the core.

The service-based architecture

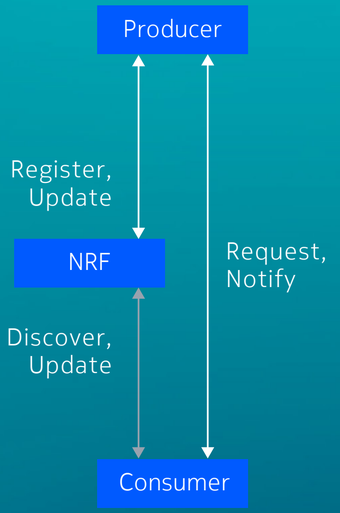
Service-based architecture (SBA) was added by 3GPP to the 5G standard. 4G and earlier generations used a peer-to-peer arrangement where network elements were provisioned in a fixed way to communicate with other network elements. SBA, in contrast, treats NFs as independent entities that discover the capabilities of other NFs in their core network. This makes the network far more dynamic. Operators can more easily scale networks, bolster redundancy for greater reliability, and extend the network by adding new functions for rapid service innovation.

In SBA, each NF registers itself as a producer of services with the Network Repository Function (NRF) communicating over a service-based interface (SBI) bus. The NF can request as a consumer to be matched to other producers for the services it needs. The NRF acts like a matchmaker that coordinates producers and consumers dynamically, enabling the network to automatically modify connections to accommodate changes to the core network scale, capabilities or redundancy approach.

5G service-based architecture



NF relationships



The NRF is the database that maintains the record of available NFs and their supported services. Without it, the core reverts to a peer-to-peer architecture with fixed connections between the NFs.

The 5G Standalone core's SBA provides major benefits to the service provider. It creates a highly flexible network core that is independent of the underlying hardware infrastructure. SBA enables fluid scaling, high reliability, and a flexible service environment that allows the CSP to rapidly introduce new service offers. In fact, exciting new capabilities of 5G such as ultra-reliable low-latency communications (URLLC), massive machine-to-machine communications (mMTC), mobile edge computing (MEC), and network slicing cannot be implemented at all without the 5G Standalone core's SBA.

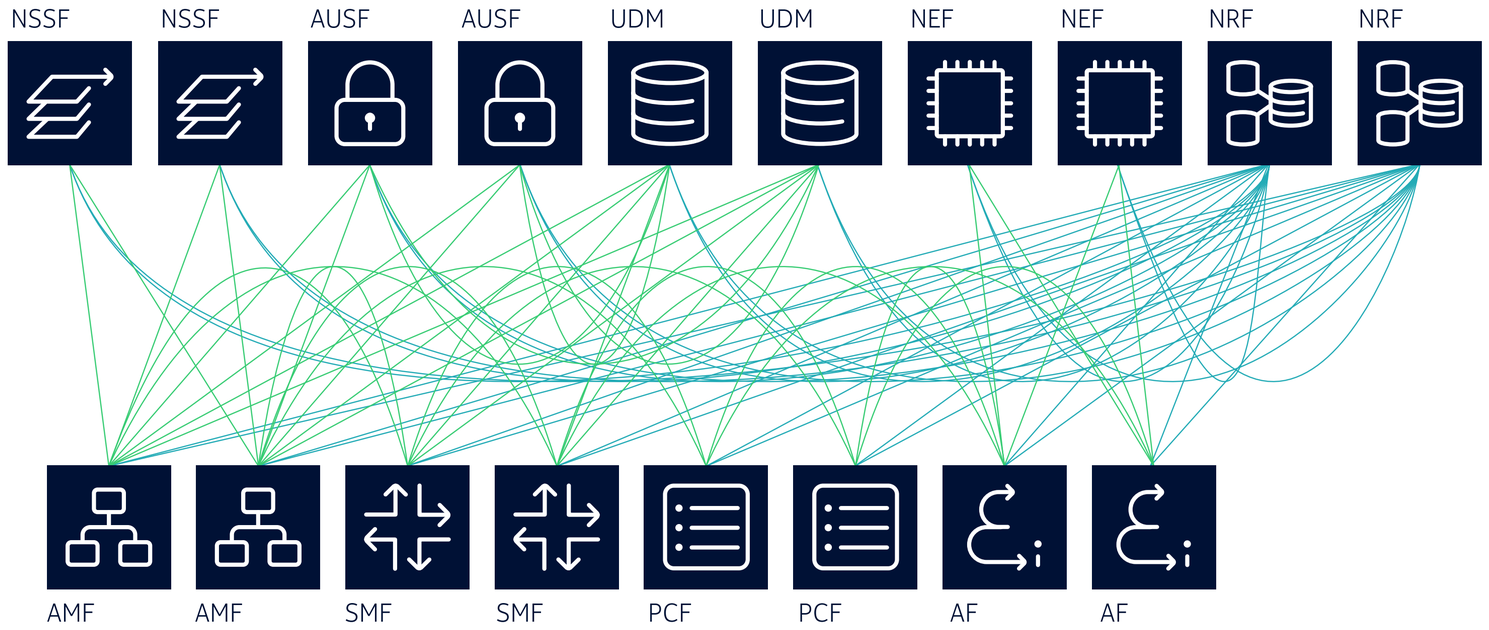
5G's service-based architecture is essential for realizing advanced 5G services.

Signaling and the service communication proxy

The SBI bus is an abstraction of the connections between the NFs in the 5G core. In reality, each NF has point to point connections to the NRF, and to any other NFs needed to perform its job. These connections are encrypted links that are manually provisioned when the network is constructed, and manually maintained over the life of the network.

Although not every function is connected to every other function, as the network expands in size, the number of connections required to maintain grows exponentially. For example, a small network with 200 core NFs will have thousands of links to maintain. Each time a new NF is introduced, the CSP will need to provision its links to the NRF and to all other NFs to which it might need to communicate.

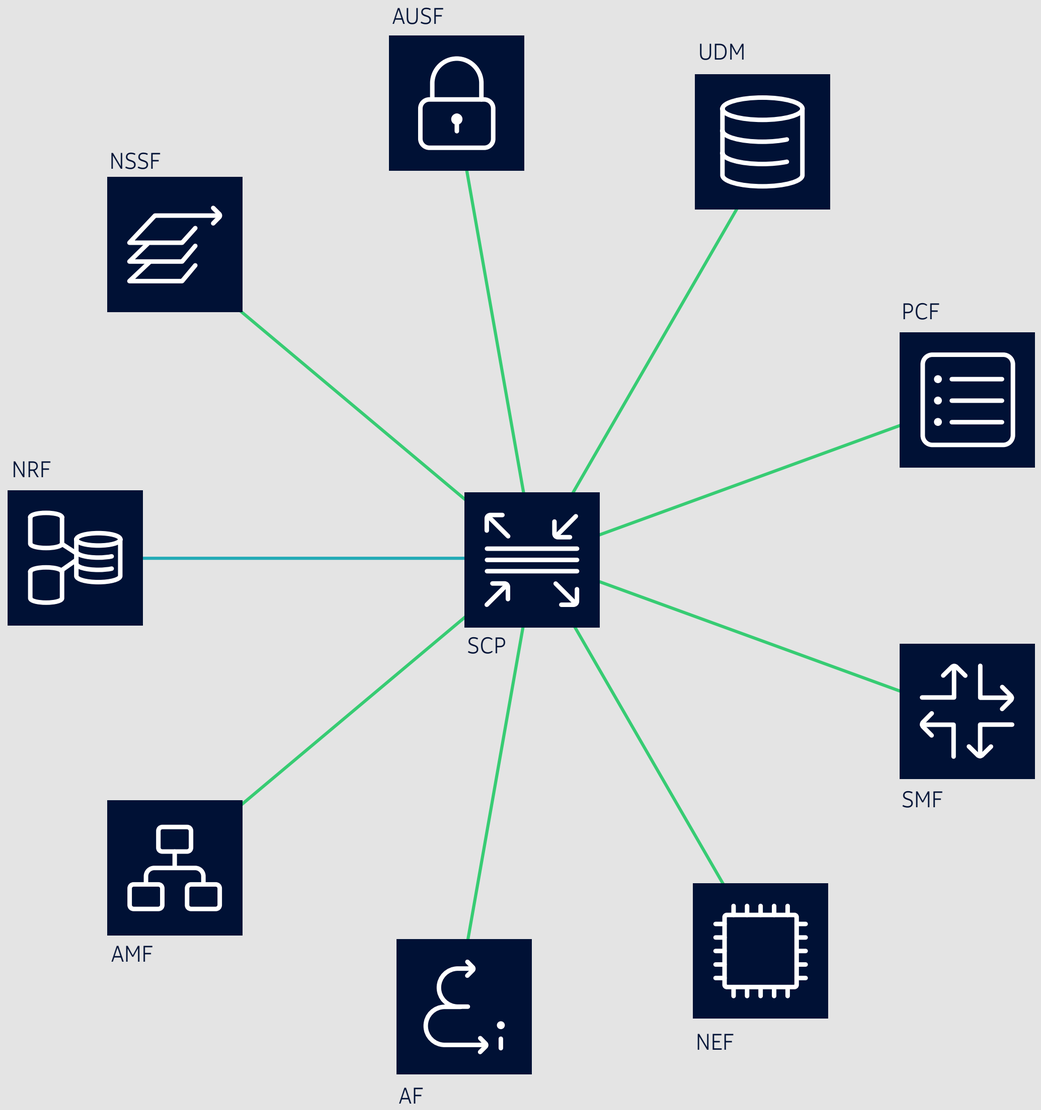
Without some kind of proxy, a network designed in this fashion does not really implement the automatic self-configuration envisioned by SBA, nor can it scale well.



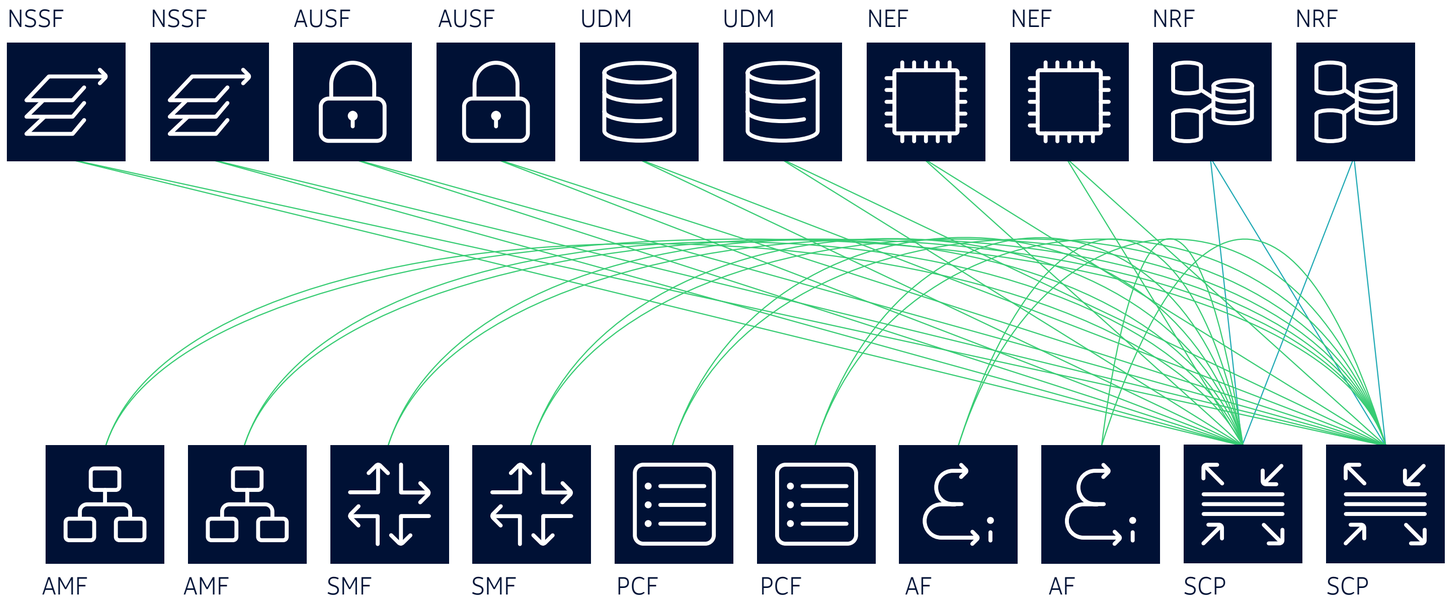
The SBI bus in reality consists of many point to point connections between network functions.

The SCP simplifies the core

So 3GPP in Release 16 introduced the Service Communication Proxy (SCP). This NF changes the signaling to a hub- and-spoke approach, with the SCP acting as the communication hub for other NFs. When a new NF is introduced, it needs only to be connected to the SCPs and the NRFs in the core, rather than directly to all other NFs that it may (or may not) use.



5G core with redundancy in a signaling model D arrangement



Since the SCP was introduced only in 5G Release 16 (Rel-16), CSPs who deployed 5G Standalone (SA) core prior to this release did not have the option to include an SCP. But nearly all CSPs today plan to move to a full SBA approach with the SCP.

Today, most telecom equipment vendors with a 5G SA core offer also offer an SCP product. There are also niche players who only offer the signaling elements of the 5G core. Because the SCP has only recently been standardized, vendors are at differing levels of maturity with their SCP offerings.

Nevertheless, an SCP is essential to scale 5G SA networks.

Benefits to this approach:

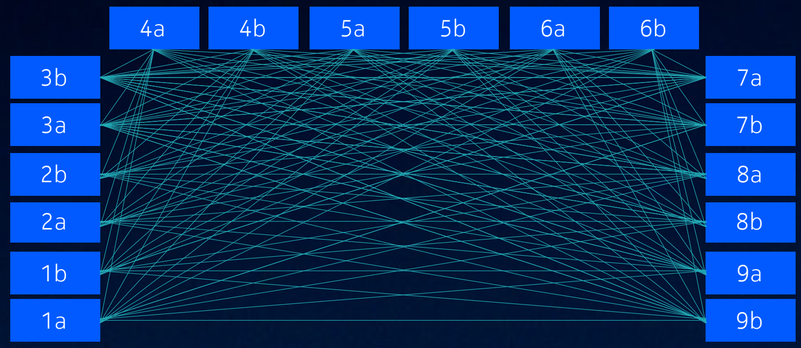
- Network faster and easier to deploy
- Network far easier to scale up
- Signaling subdomains make operations easier
- Fewer connections to manage
- Load balancing with NF logic required

The four signaling models

There are four standard signaling models: model A, model B, model C and model D. These models describe how the signaling interconnections are made between the NFs in the 5G core, and to the NRF and SCP. Since the SCP was introduced in 3GPP Rel-16, early movers used model B. However nearly all CSPs view models C or D as their target architecture for core signaling to allow for network scaling, and most have plans to transition when practical. Nokia advises that new network builds should target model D from the very start to minimize deployment costs.

Signaling model A

Model A involves directly connecting every NF to every other NF with which it may need to communicate. There is no NRF, so this model does not implement an SBA. Model A does not scale well and is only suitable for lab and proof of concept applications. Commercial 5G core deployments will always use one of models B, C, or D.



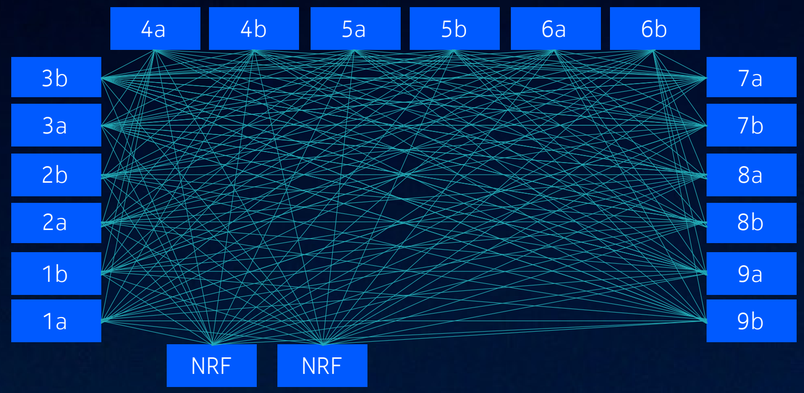
Thousands of connections
Hundreds of integrations

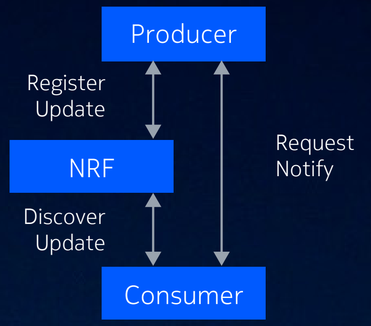
Direct consumer to producer connection

Model A is only used for labs and proof of concept demonstrations.

Signaling model B

In model B, an NRF is part of the architecture, thus allowing for an SBA arrangement. Each NF is directly connected to every other NF, and also directly connected to the NRF. When a new NF is added, it registers with the NRF, and queries the NRF for its producers. It is required, however, that connections be pre-provisioned from the NF to the other NFs in advance. This eliminates the main benefit of SBA: automatic communication with appropriate producers and consumers. Early 5G SA core deployment used model B since the SCP was only introduced in 3GPP Rel-16.



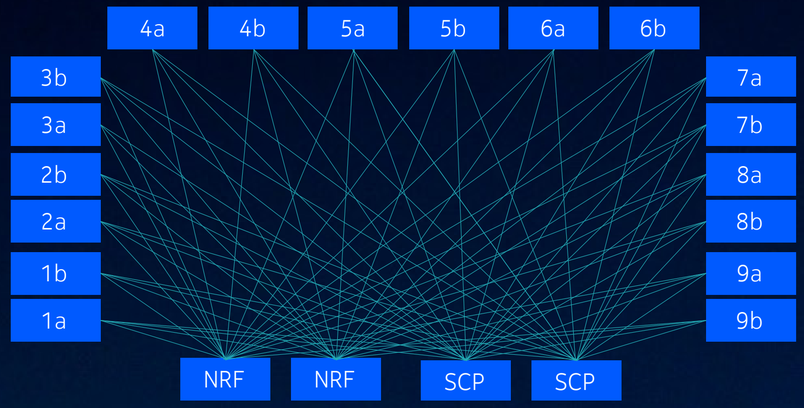


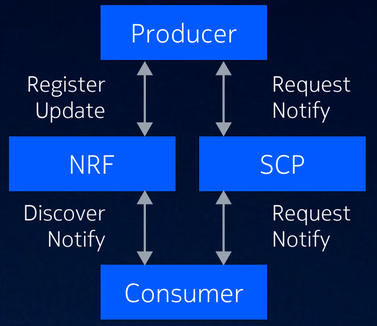
Even more connections and integrations

Model B is today proposed only by vendors who do not have a viable SCP product.

Signaling model C

Model C adds an SCP into the network. NFs are no longer directly connected to one another. Instead, all NFs are provisioned with a connection to the relevant NRFs and also to the relevant SCPs. Network functions query the NRF for producers that they need, and then interface with the other identified NFs through the SCP as a proxy. This allows for the full power of the SBA to be realized, but does not result in the minimum number of pre-provisioned connections. This model is used when the SCP is mature enough to handle the added load of delegated discovery.





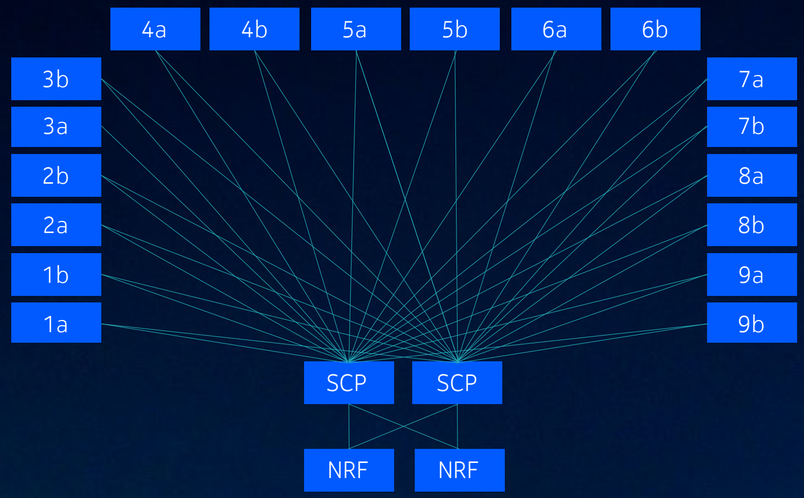
Tens of connections
Tens of integrations

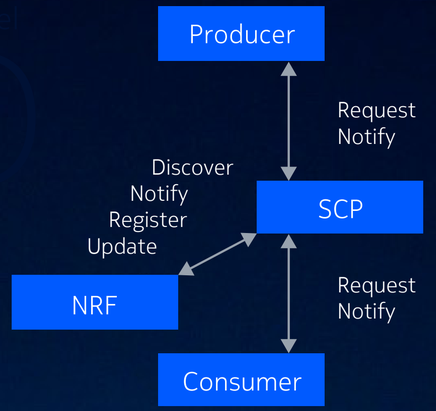
Basic SCP function

Model C is usually proposed by vendors who have an underpowered SCP.

Signaling model D

In model D, all NFs are provisioned with connections to their local SCPs. The SCPs are also connected to the NRFs. When an NF needs to connect to a producer, it queries the NRF through the SCP, which returns the appropriate producers as a response from the NRF. This is called “delegated discovery.” Then, to communicate with the discovered producers, the NF interfaces with them again through the SCP, which is a proxy. Model D is the target architecture for most service providers, since it has the greatest simplicity, realizes the full SBA vision, and generally results in the lowest operational costs.





Minimum connections and integrations

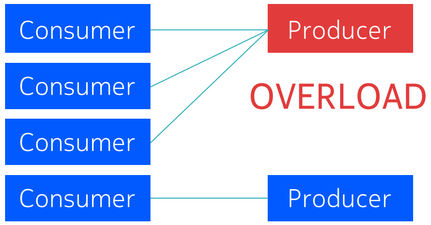
Model D is only proposed by vendors with a fully capable SCP.
This is the target architecture for nearly all 5G service providers.

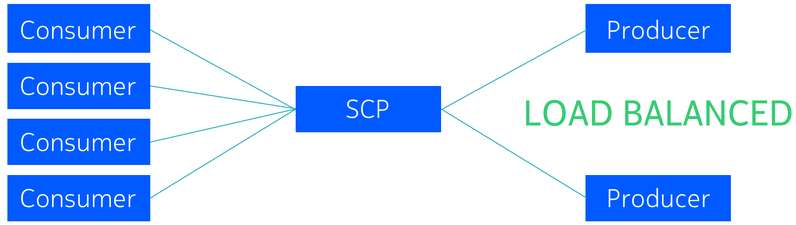
Use cases for SCP in the 5G core

As 5G networks evolve to offer more advanced capabilities, CSPs must ensure the 5G core can deliver reliable, high-performance services. Yet the cloud-native 5G core introduces complex signaling demands. There are several important use cases for the SCP in a CSP network that help to meet these demands.

Load balancing

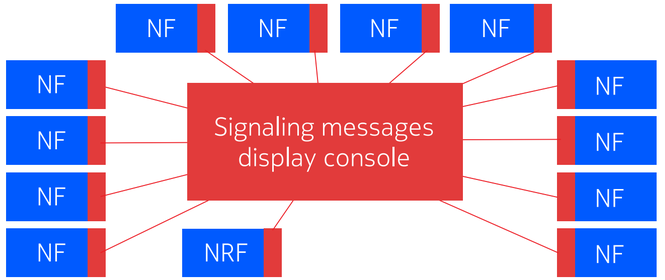
Since the SCP acts like a traffic switch between NFs, it provides an ideal place to perform load balancing between NFs in the 5G core. This helps to avoid NF overloads and ensures reliable, high-performance customer experiences. It balances demand on the NF service instances, achieving faster time to market for new services and upgrades. Load balancing also increases core network efficiency because the instantiated NFs are more fully used.



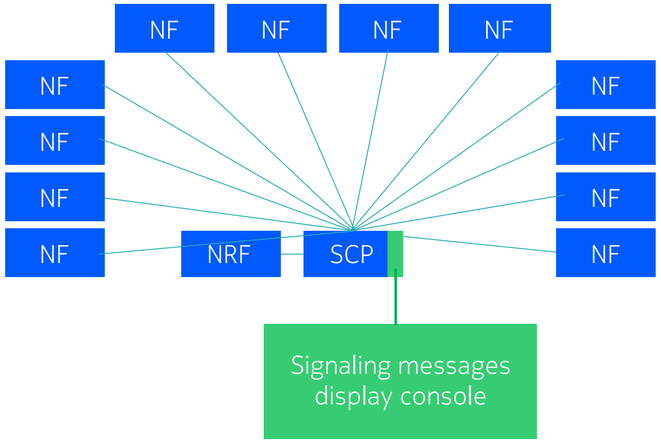


Single probe

Because of its location, the SCP provides an ideal place to create a single point for probing and tracing. A probe placed as software within the SCP, or even externally with shared credentials, can monitor all signaling traffic between performance and proper functioning of the core. Later, during network operations, it provides valuable information that can be used to quickly identify and resolve issues that may arise due to changing service traffic patterns or due to network configuration changes.



Individual probe for every network function to decrypt messages for each signaling link

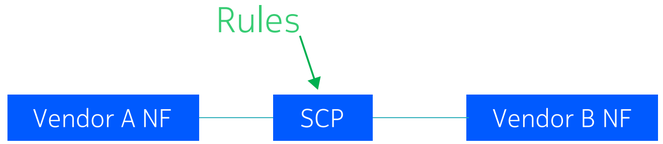


Single probe at SCP where all messages are decrypted in one place

Protocol adaptation

The SCP as a proxy provides the opportunity to introduce protocol adaptation between NFs. This may be needed when the NFs come from different vendors and implement a common communication protocol slightly differently. It may also be needed to fix some interaction issues, even for NFs from the same vendor. With a high performance protocol adaptation engine embedded in the SCP, it can be programmed to modify messages between NFs to resolve these mismatches. This is useful in network deployment to temporarily resolve problems that could block deployment, and also in operating networks, especially when new NFs are added.

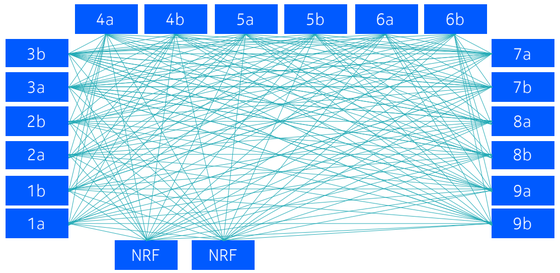
Protocol mismatch for any reason requires new software load from one vendor



Protocol mismatch adapted by rules engine in the SCP on the fly

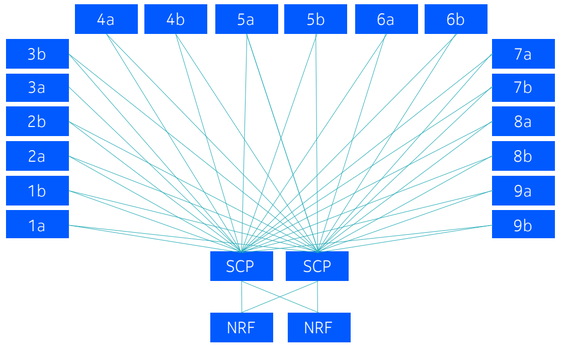
Full SBA support

Without the SCP, support for the vision of the SBA is limited. Although the NRF is the only element required to implement basic SBA, NFs need to be pre-provisioned with connections to every other NF that may be required, regardless of whether the NRF identifies that partner function as a producer or not. This is inefficient. The SCP allows for dynamic creation of communication paths between NFs based on the needs of the NF, and current state of the network.



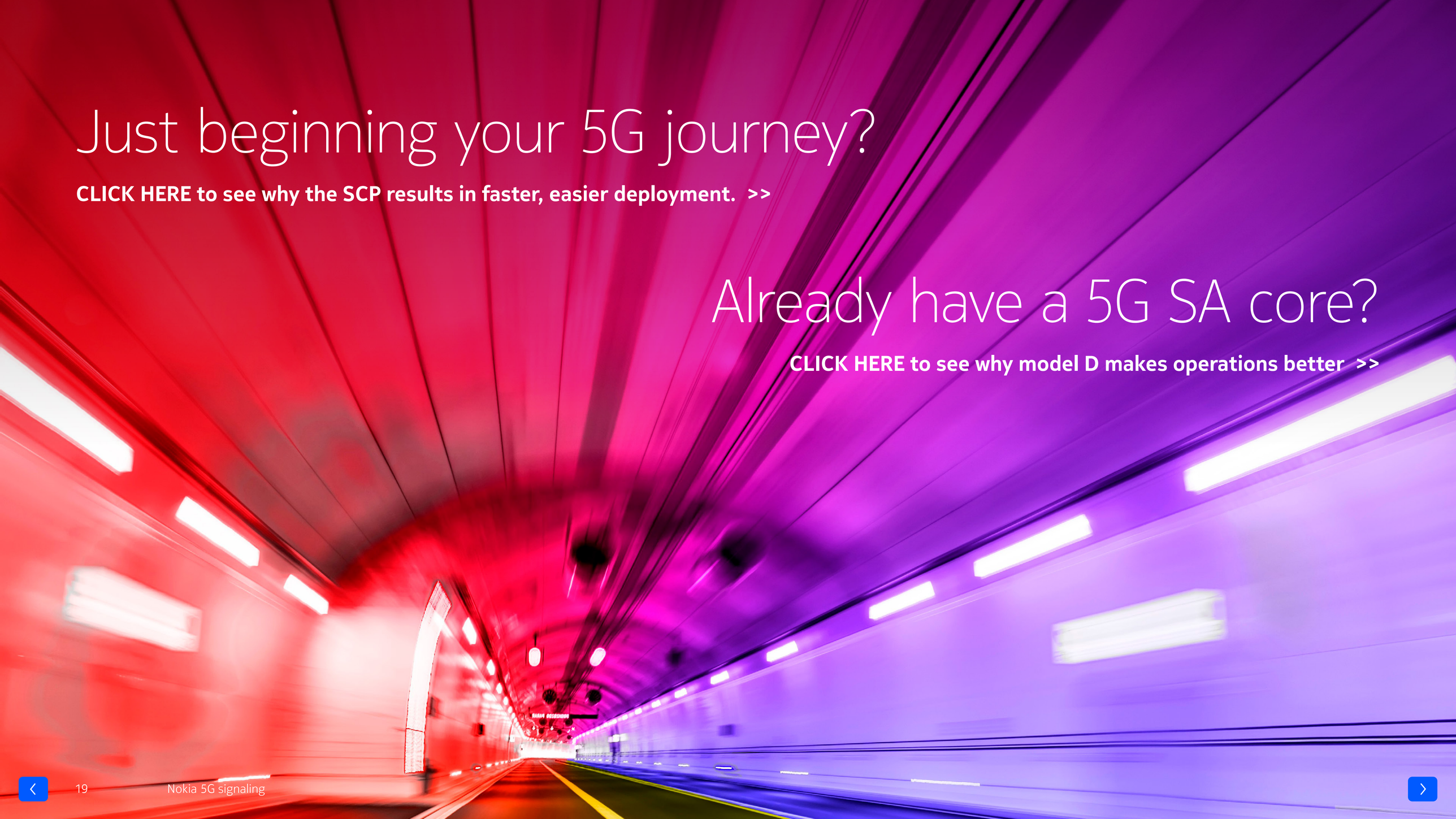
NRF matches producers to consumers

But consumers still connect to every producer



NRF matches producers to consumers

Consumers connect only to their producer


Just beginning your 5G journey?
CLICK HERE to see why the SCP results in faster, easier deployment. >>
Already have a 5G SA core?
CLICK HERE to see why model D makes operations better >>

Faster and easier 5G deployment with SCP

Service providers who are deploying a 5G SA core should include the SCP from the start of the project. This reduces the total investment required for the project, even though the CAPEX cost of the SCP is included up front. Here are four ways that the SCP saves you time and money in your initial 5G deployment.

Reduced connections

During deployment, each connection between one NF and another must be manually provisioned, with appropriate encryption certificates. Including an SCP from the start reduces the number of connections required and, thus, the effort required for the deployment.

Reduced integration

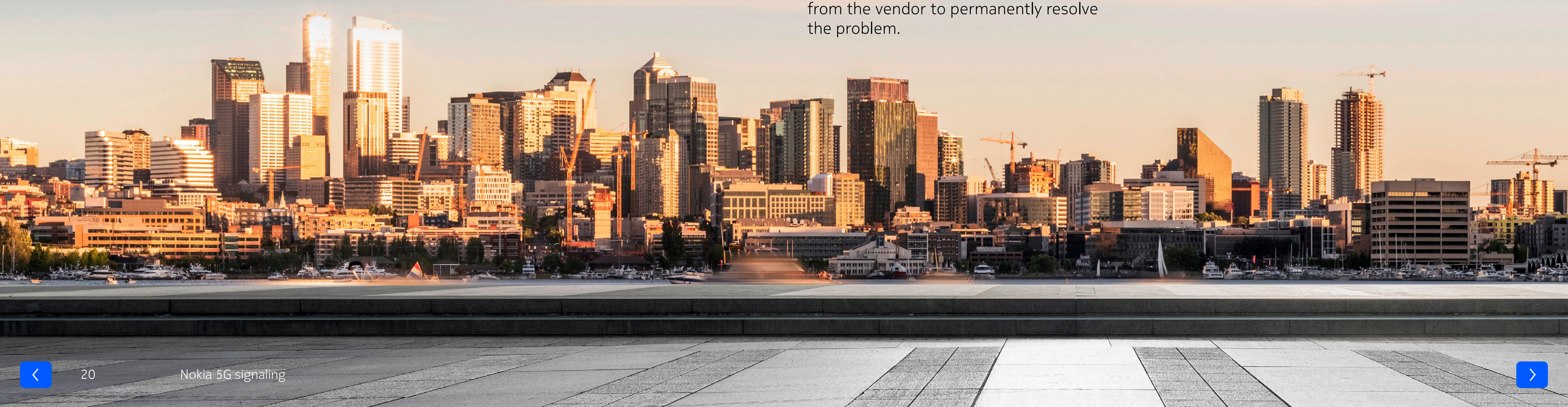
With an SCP, NFs that are connected directly to other NFs means that the two must be integrated. This results in many pairwise integrations, which increases the cost of the project. With an SCP in the design, the NFs must only be integrated with the SCP, reducing costs.

Protocol adaptation

The SCP provides a natural point where protocol adaptation can be implemented between two NFs, for example, if they come from different vendors. Adaptation can be put into place if an issue is found, allowing the deployment to proceed while one or both NFs await a software update from the vendor to permanently resolve the problem.

Single probe

With an SCP acting as a signaling hub, only a single probe point is required to see all the messages between every NF. Without the SCP, a probe is required for every NF for full visibility. This enables rapid diagnosing of problems during deployment.

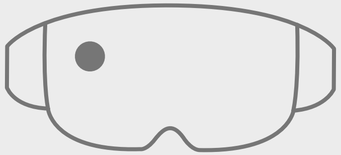


Making network operations more efficient with SCP

Is an SCP actually required for the 5G core in the long term? The answer is yes! The model D signaling architecture, with the SCP providing delegated discovery, results in a network that is less costly to operate and is far more flexible for distributed network arrangements.

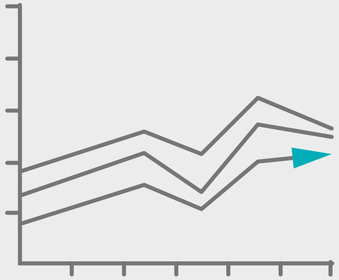
Reduced operations costs

The number of signaling connections grows linearly with an SCP, and exponentially without. As a network grows, this will save costs in provisioning and managing the links between NFs, especially as the network scales upwards.



Faster launch of new services

As you add new services to your 5G network, you will need add NFs — either to increase the capacity of existing functions or to add entirely new capabilities to the core network. Protocol adaptation in the SCP, plus the ability to truly take advantage of the SBA's automatic configuration helps you launch these new services faster.



Maintain premium customer experience

Networks occasionally run into unforeseen problems like signaling storms or unexpected interactions between NFs — especially when multiple vendors are involved. The SCP's ability to serve as a single point for probing and tracing, coupled with real-time protocol adaptation, makes diagnosing such problems faster and easier, allowing you to ensure that your customers are not impacted. The SCP helps keep you maintain a premium customer experience.

Nokia’s 5G signaling supercharges your network

Nokia’s 5G signaling solution brings value to both your 5G standalone deployment, and also the operation of your network as it grows and matures. Our solution, the Nokia Cloud Signaling Director (CSD), provides several important signaling NFs for the 5G core: the SCP, as well as the Security Edge Protection Proxy (SEPP), and Binding Support Function (BSF). With CSD, you gain a proven, high performance signaling infrastructure that gets your 5G core network deployed and operational fast, and saves you money in the process.

The world’s first, live model D network

Nokia helped one of our customers deploy the world’s first network based on model D, and this network was also the world’s first to go live in this configuration. Model D means the SCP is handling the full load of the SBA, and realizes the vision the 3GPP had in mind when the SCP was standardized.

While other vendors promise model D support in the future — we offer it today.

Low latency adaptation at near line rates

The Nokia Advanced Rules Technology (ART) engine, a key component of the CSD, provides protocol adaptation at near line rates, while introducing almost no latency. This flexible rules engine modifies signaling messages on the fly, making it easy to adjust network performance and fix issues that may occur during deployment or operation without modifying the core network’s configuration or functions. If you identify a problem, you can patch it fast, giving you time to find a long-term solution without impacting customer experience.

True service-based architecture

The Nokia solution delivers a true SBA with delegated discovery and efficient load balancing. Easily add new services with additional NFs automatically finding and connecting to their producers and consumers, just as intended by the 3GPP SBA vision. The network is the most efficient it can be, with the load evenly spread. Take advantage of distributed 5G core networks, with distributed SCPs managing their respective domains.

Ready to talk?

Talk to a Nokia specialist to find out how Nokia signaling can help you get the most out of your 5G network.

Get more insights and information

Hot topics

- 5G core
- Automated network slicing
- Core automation
- Core networks on public and hybrid clouds
- Open ecosystem network

5G core NFs

- Cloud Packet Core (CMM, CMG, CNRD) and its eBook
- Cloud Signaling Director
- Converged Charging
- IMS / Voice over 5G
- Network Exposure Function
- Policy Controller
- Shared Data Layer
- Subscriber Data Management (Registers)

Orchestrate, assure, manage

- Cloud Operations Manager
- Digital Operations Center
- NetGuard
- Nokia Container Services

5G core services

- Cloud Network Services
- DelOps, CI/CD services
- Service lifecycle automation for the 5G core

Abbreviations

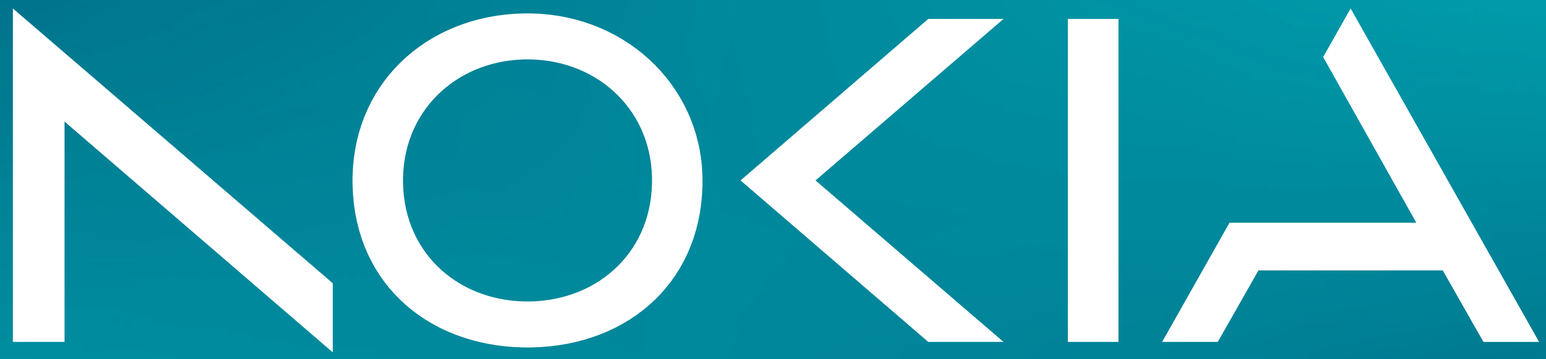
3GPP	Third Generation Partnership Project
ART	Advanced Rules Technology
BSF	Binding support function
CSD	Cloud Signaling Director
CSP	Communications service provider
IoT	Internet of things
MEC	Mobile edge computing
mMTC	Massive machine-to-machine communications
NF	Network function
NRF	Network repository function
Rel-16	3GPP Release 16
SA	Standalone
SBA	Service-based architecture
SBI	Service-based interface
SCP	Service communication proxy
SEPP	Security-edge protection proxy
URLLC	Ultra-reliable low-latency communications
VNF	Virtual network function

Nokia OYJ
Karakaari 7
02610 Espoo
Finland

Tel. +358 (0) 10 44 88 000

CID:212567 (March)

nokia.com



At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering the future where networks meet cloud to realize the full potential of digital in every industry.

Through networks that sense, think and act, we work with our customers and partners to create the digital services and applications of the future.