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Rethinking Network Architecture: Enabling Service-Based Design Beyond 5G

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***Abstract*—The Service-Based Architecture (SBA) has been successfully employed in the 5G Core since Release 15. Its modular and loosely coupled approach to network function interaction, based on the producer/consumer paradigm, perfectly pairs with the softwarization trend mobile networks have undergone over the last decade. Still, the Radio Access Network (RAN) did not leverage this approach, retaining the traditional Protocol-Based Architecture (PBA). In this paper, we make the case for adopting the SBA in the RAN, a transition we argue is both advantageous and feasible. We first present a comprehensive analysis of the benefits, such as enhanced flexibility and innovation, while also considering potential implementation challenges. Then, we detail how the SBA can be used to provide two exemplary procedures currently performed using the PBA, showing the feasibility of a fully service-based 5G network architecture.**

***Index Terms*—SBA, RAN, 6G, network architecture.**

I. INTRODUCTION

The evolution of mobile communication networks towards 5G and beyond is involving a fundamental shift in network architecture design to meet increasingly stringent requirements for flexibility, scalability, and service differentiation. The traditional Protocol-Based Architecture (PBA), which organizes network functions in rigid, hierarchical stacks, struggles to efficiently support the dynamic service demands, low latency, and ultra-reliability expected in current- and next-generation networks. To address these challenges, the Service-Based Architecture (SBA) has emerged as a cornerstone of 5G core network design, introducing a modular and service-oriented approach that redefines how network functions interact and operate.

SBA departs from legacy network paradigms by treating network functions as loosely coupled services that communicate over standardized interfaces using web-based protocols. This service-oriented approach enables dynamic discovery, registration, and invocation of network functions, thereby fostering a flexible and programmable network environment. Through the decoupling of control and user planes and the abstraction of network functionalities into microservices, SBA supports enhanced scalability, simplified integration, and faster service innovation. This paradigm shift aligns closely with cloud-native principles, facilitating deployment in virtualized and containerized environments and enabling seamless orchestration across heterogeneous network domains.

While the adoption of SBA in the 5G Core Network has been standardized and widely discussed, its extension to the RAN introduces new dimensions and challenges. Implementing SBA principles in the RAN, which has traditionally been tightly coupled and hardware-centric, demands rethinking both infrastructure and operational models. However, the potential benefits, which include increased modularity, agility in service provisioning, and improved resource utilization, make SBA a compelling architectural direction not only for 5G but also for future 6G mobile networks.

The introduction of a SBA in the RAN represents not only a structural evolution of the network but also a key enabler for realizing the vision of programmable networks. By decoupling functions and exposing them as discoverable and composable services, the RAN becomes inherently more flexible and responsive to dynamic service requirements. This architectural shift also facilitates the seamless integration of advanced capabilities, including AI/ML-driven functions, which can be embedded into the service fabric to support real-time optimization, predictive management, and context-aware decision-making. Ultimately, the combination of a service-based design and programmable, AI-enabled functionalities paves the way toward a highly adaptive, scalable, and intelligent RAN, capable of efficiently meeting the diverse and evolving demands of next-generation applications and services.

This paper discusses implications of the SBA paradigm for the RAN. First, we provide an overview of the SBA and highlight its inherent advantages over the traditional PBA. Second, we identify and analyze the technical requirements that the RAN infrastructure and operations must satisfy to support the SBA model effectively. Third, we detail the specific benefits that SBA introduces to the RAN, including improved modularity and operational efficiency. Finally, we illustrate the practical realization of SBA in the RAN by presenting concrete examples of its application in key functions such as User Equipment (UE) registration, which were developed within the framework of the ORIGAMI [1] and RESTART [2] projects.

II. A PRIMER ON SERVICE-BASED ARCHITECTURES

The SBA has been successfully introduced in the Core Network architecture since Release 15, disrupting the PBA that

TABLE I
COMPARISON OF SERVICE-BASED AND PROTOCOL-BASED ARCHITECTURES

Aspect	**Service-Based Architecture (SBA)**	**Protocol-Based Architecture (PBA)**
Modularity & Flexibility	✓ Highly modular: functions exposed as independent, reusable services via APIs	✗ Rigid layering with tightly coupled protocol stacks
Interoperability	✓ Enables vendor-agnostic integration through open, standardized interfaces (e.g., REST)	✗ Interfaces often proprietary or semi-standardized
Scalability	✓ Supports dynamic scaling of individual services based on load or demand	✗ Scaling typically applies to entire network functions or elements
Upgradability	✓ Individual services can be upgraded or replaced independently	✗ Software updates often require revalidation of entire function stack
Observability & Telemetry	✓ Fine-grained telemetry per service, enabling better analytics and closed-loop automation	✗ Monitoring is often coarse-grained and tied to protocol endpoints
Automation & AI Integration	✓ Natively supports closed-loop automation and AI/ML-based optimization	✗ Automation is limited to predefined rule sets or external tools
Latency & Performance	✗ May introduce overhead due to service granularity, API calls, and message translation	✓ Efficient runtime performance with tightly integrated protocol layers
Operational Complexity	✗ Requires sophisticated orchestration and service discovery mechanisms	✓ Simpler runtime behavior; deterministic function execution paths
Security Surface	✗ Increased attack surface due to exposed services and APIs	✓ Smaller attack surface with fewer external interfaces
Legacy Compatibility	✗ Requires adaptation layers to interoperate with protocol-based systems	✓ Direct compatibility with existing legacy systems

was introduced since the early releases of the mobile system and lasted through Release 14.

SBAs, also known as Service-Oriented Architectures (SOAs), are based on the *Service* concept, which implements a specific functionality. SBAs are *distributed* architectures where service components can be accessed remotely, increasing the *modularity* of the design.

All these characteristics matched very well with the technology trends available one decade ago, when the standardization work on 5G started, where the impact of Software Defined Networking (SDN) and Network Function Virtualization (NFV) were at the basis of the network *cloudification* that motivated the introduction of the SBA in the core. SBA aligned very well with this view.

More than ten years later, the SBA design not only proved useful to meet technological trends related to virtualization, but also to natively integrate the AI/ML solutions using the producer-consumer interaction.

A. SBA in a nutshell

In a nutshell, the services comprising an SBA have the following characteristics:

- A service is a closed box whose internal design and characteristics are of no relevance.
- A service performs tasks that satisfy a specific set of requirements.
- A service is realized by a Service Producer (SP) entity.
- The SP is responsible for registering its provisioned service in one or more Service Directory (SD) entities.

The other end of the basic exchange depicted in Figure 1 are Service Consumers (SCs), which access services without prior knowledge about the catalog of available ones. They are also not aware of the Service Access Point (SAP) of the provisioned service. To this end, SCs can retrieve from the SD the necessary information (using the *locateService* procedure). Once the SC discovers the desired provisioned service and its associated SAP, it can contact the SP and start consuming the desired provisioned service.

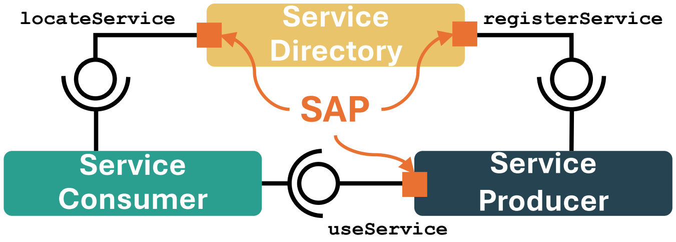

Fig. 1. SBA components and their interactions.

B. Advantages of the SBA approach in the RAN

5G has been designed to have a clean separation between the RAN and Core, with only a few control-plane and user-plane interfaces crossing the two traditionally distinct domains (since the very first generation of mobile network architecture). While this approach favoured their standalone operation and decoupling, the increasing impact of cloudification, also in the access network, made this approach fall behind possible new use cases or requirements, such as the tight integration of resources with access network functions. Table I shows the advantages of an SBA approach compared to a PBA one, especially for the RAN.

While the advantages provided by the SBA approach perfectly fit the softwarization trend currently happening in the network design, open gaps arise, especially in the performance, security, and legacy compatibility points of view. Thus, network functions operating on the SBA should pay particular attention to these points.

- **Performance and Latency.** Not all functions in the RAN are suitable for being directly integrated into the SBA. Some control loops (such as the ones between the lower parts of the MAC and the physical layer) should not be integrated in the SBA and should keep PB approaches.
- **Operational Complexity.** Discovery protocol shall be enabled also in the RAN, integrating current efforts already taking place in the 5G Core, as well as specific RAN orchestration components such as the one available in Open RAN (O-RAN).
- **Security Surface.** Security on RAN interfaces has attracted attention in the past few years. These efforts are instrumental for the SB transformation of the RAN.
- **Legacy Compatibility.** The transition towards SBA necessarily involves the utilization of gateways and translation to the new paradigm, to guarantee a smooth transition towards the new generation.

In the following, we discuss in more detail the technical enablers for the transition of the RAN components to an SBA.

III. TECHNICAL REQUIREMENTS FOR THE INTRODUCTION OF SBA IN THE RAN

Replacing protocol-based network functions with services in a SBA requires evaluating specific criteria to ensure suitability:
Functional decoupling: The function should be logically self-contained and not tightly dependent on specific message sequences or implicit shared state. If it can be exposed as a clear API, it is a strong candidate for service transformation.
Statelessness or explicit state handling: SBA favors stateless services or those where state is explicitly managed via external repositories. Functions relying on deeply distributed or implicit state may require significant redesign.
Modularity and reusability: The function should be modular and reusable across multiple consumers or components. If it serves only a single, specific purpose for a single node, turning it into a service may not be justified.
Temporal independence and asynchronicity: SBA promotes asynchronous or on-demand interactions (e.g., REST, HTTP/2, HTTP/3, etc.). Functions requiring tightly coupled real-time communication may not translate well into SB models.
Well-defined interfaces: The function must provide a contract-first API with clear input/output parameters, defined behavior, and error handling. Legacy functions with implicit behaviors can be difficult to expose cleanly.
Observability and manageability: The service must be observable, independently scalable, and manageable. Functions that cannot be monitored or orchestrated in isolation may not suit a service-based implementation.

Furthermore, the increasing complexity and heterogeneity of emerging 6G services, together with stringent requirements in terms of flexibility, sustainability, and cost efficiency, call for a fundamental rethinking of the RAN architecture. In this context, we propose an approach to designing a SBA for the 6G RAN, inspired by the principles already established in the 5G Core and extending them to meet the unique challenges of the RAN domain.

At its core, the proposed SBA for the RAN is designed to comply with a set of essential baseline requirements that any service-based system should fulfill, ensuring robustness, interoperability, and scalability:

- **Service Discovery and Registration**: Each RAN function is exposed as an independent service, uniquely identifiable and dynamically registered in a service repository. SCs can query this repository to discover available producers and their capabilities at runtime.
- **Network-Level Connectivity**: The architecture ensures end-to-end reachability between service consumers and producers over the RAN and beyond, leveraging a service bus or equivalent message routing layer to enable seamless communication.
- **Security and Access Control**: Robust mechanisms for Authentication, Authorization and Accounting (AAA) are embedded in the architecture to enforce trust and policy compliance across service interactions, even in highly dynamic multi-stakeholder environments.
- **Service Invocation and Routing**: The architecture provides dynamic service invocation and intelligent routing, abstracting SCs from the underlying physical topology and enabling flexible orchestration of RAN functions.
- **Monitoring**: Each service is instrumented to expose standardized metrics and events, enabling closed-loop automation, fault detection, and performance optimization.
- **Interoperability and Extensibility**: The design promotes vendor-neutral, standardized interfaces to minimize proprietary dependencies, allowing easy integration of new services, including AI-driven modules and Digital Twin instances, as the network evolves.

This approach envisions the RAN not as a monolithic, protocol-bound entity but as a programmable, morphable set of services, capable of adapting dynamically to the variability in user demand, mobility patterns, and service requirements typical of 6G scenarios (see [3]). The integration of semantic descriptions of services and intent-based orchestration mechanisms further enhances the system's capability to adapt and self-optimize across domains. By adhering to these principles, the proposed SBA for the 6G RAN addresses critical challenges in achieving flexibility, economic lifecycle management, energy and resource efficiency, and environmental sustainability, key pillars of the 6G vision.

Adopting a SBA in the design and deployment of the 6G RAN introduces significant advantages, including:

- **Architectural Flexibility**: Dynamic composition and reconfiguration of network functions to adapt to changes in user density, mobility patterns, service types, and traffic load.
- **Reduced Vendor Lock-in**: Clear separation between service producers and consumers encourages open interfaces and minimizes reliance on proprietary solutions.
- **Network Lifecycle Cost Efficiency**: Modular design simplifies the deployment, upgrade, and decommissioning of individual services, reducing OPEX and CAPEX.

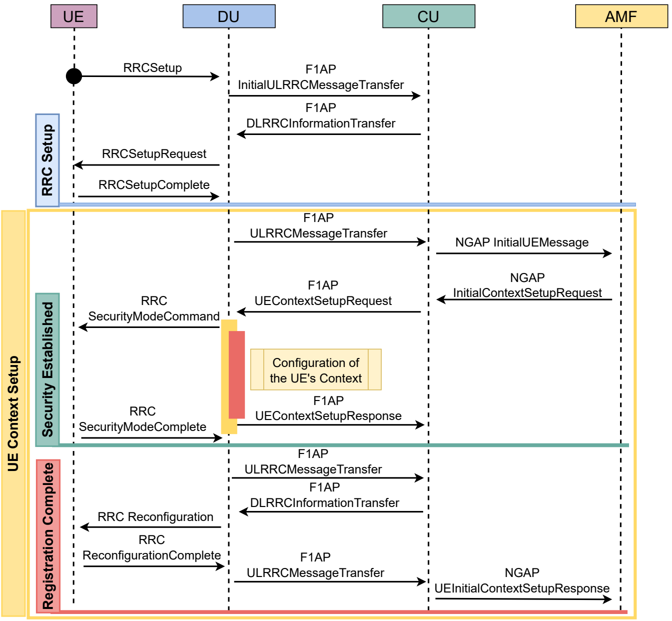

Fig. 2. Protocol Based UE Context Set Up procedure

- **Seamless AI Integration**: Native support for plug-and-play AI-driven functions (e.g., mobility prediction, anomaly detection), including their training, deployment, and lifecycle management.
- **Cloud-Native Alignment**: Tight integration with cloud-native infrastructure (containers, orchestration of microservices) enables on-demand resource scaling and improved resilience.
- **Enhanced Observability and Automation**: Built-in service exposure and API-based telemetry for advanced monitoring, policy control, and intent-based automation.
- **Cross-Domain Coordination**: Facilitates multi-domain orchestration (RAN, core, edge) via service interfaces, enabling end-to-end agility and user-centric optimization.

All of them motivate the SB transformation of the RAN, as we propose next.

IV. TRANSLATION OF PROCEDURES

In the following, we discuss how two exemplary procedures can be transformed using the SBA approach.

A. *UE Registration*

The registration process starts once the UE is synchronized with the next-generation NodeB (gNB), in both time and frequency through the *Cell Search* procedure, and uses the Random Access Channel (RACH) to properly get uplink (UL) synchronization and obtain an identifier, which is key for the radio communication through the *Random Access* procedure.

Once the UE is ready to communicate with the gNB, it initiates the establishment of a Radio Resource Control (RRC) connection, which is vital for radio resource acquisition as depicted in Figure 2. Then, when the Centralized Unit (CU) receives the *RRCSetupRequest*, it creates the context (i.e., the set of relevant information required by the gNB to handle the connection, including the UE identity [4]) for the UE. It replies with an *RRCSetupRequest* message containing the RRC parameters to establish Signaling Radio Bearers (SRBs), Data Radio Bearers (DRBs), and additional MAC and PHY configurations (e.g., logical channel settings). The UE acknowledges successful application of the configuration through the *RRCSetupComplete* message, which confirms completion of the RRC setup and carries the initial Non-Access Stratum (NAS) message: the *RegistrationRequest*.

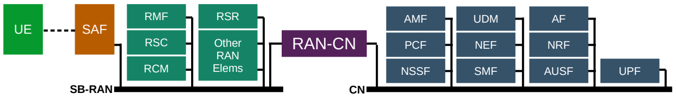

Fig. 3. RAN Service Based Architecture example

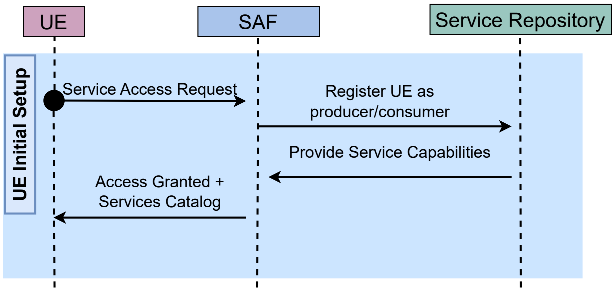

Fig. 4. UE integration in the RAN SBA

Upon arrival at the CU via the Distributed Unit (DU), the *RegistrationRequest* is transferred to the AMF over the NGAP interface [5], as it contains the information required to perform the UE registration in the network (e.g., Subscription Concealed Identifier (SUCI)/5G Globally Unique Temporary Identifier (5G-GUTI), UE security capabilities, or slices requested by the UE).

After this context is set, the CU awaits two responses: one from the DU related to the *UEContextSetupRequest*, and one from the UE as a reply to the *SecurityModeCommand*. A successful configuration allows the CU to continue with the RRC and NAS procedures over a secure communication channel by sending the final *RRCReconfiguration* message to the UE, which is finally acknowledged by a *RRCReconfigurationComplete*. At this point, the UE is fully configured and recognized by the network.

The proposed SBA in the RAN, depicted in Figure 3, introduces a new initial access procedure with two key components: *i)* a Service Access Function (SAF), which acts as the UE's entry point into the service-based network, and *ii)* a SD block, which maintains the catalog of available services, including those potentially offered by the UE itself.

The introduction of the SAF is a key enabler of the SBA, as we depict in Figure 4, fundamentally transforming the signaling mechanisms managing interactions between the UE and gNB-CU/DU components. In this architecture, procedures such as intra-gNB inter-DU handovers are no longer tightly

TABLE II
IDENTIFIED SERVICES ON THE N2 INTERFACE AND THEIR PURPOSE

Service Name	**Description and Purpose**
UERegistrationService	Handles initial registration, authentication, and creation of UE context in the Core Network. Ensures that the UE is recognized and admitted to the network.
PagingService	Allows the Core Network to locate and reach an idle UE when downlink data or signaling needs to be delivered.
PduSessionService	Manages the establishment, modification, and release of PDU sessions, enabling the UE to exchange user data with external networks.
MobilityControlService	Supports mobility procedures that involve the Core Network, such as AMF relocation or UE context transfer across AMFs.
ContextManagementService	Enables updates and modifications to the UE's context, including subscription data, QoS settings, and state information.
NasTransportService	Provides a transparent transport mechanism for NAS signaling messages between the UE and the AMF over the RAN, outside the scope of specific NGAP procedures. This service enables the exchange of NAS messages that are not encapsulated within other dedicated control procedures.
OverloadNotificationService	Notifies the RAN of overload conditions in the AMF or CN, and vice versa, allowing appropriate load mitigation actions.
LocationReportingService	Reports the UE's location to the Core Network to support location-aware services and regulatory requirements.
RANStatusService	Communicates RAN-related status updates, such as configuration changes, to the Core Network.
TraceManagementService	Enables tracing and recording of signaling and user-plane activities.
ErrorHandlingService	Reports errors and abnormal conditions detected in signaling or resource handling, enabling corrective actions.
UECapabilityService	Provides the UE's radio and protocol capabilities to the Core Network to ensure appropriate configuration and compatibility.
RerouteNASService	Allows the redirection of NAS signaling messages when the initially selected AMF needs to be replaced by another AMF.

coupled with direct signaling between the UE and the CU/DU. Instead, the association between the UE and the CU/DU is handled dynamically by the SAF or through service discovery via the Service Repository, effectively abstracting the UE from the underlying access node selection and coordination logic. This decoupling introduces a more flexible and modular approach to mobility and resource management, aligned with the principles of SBA.

B. Service-Based Transformation of the N2 Interface: Use Case and Service Descriptions

In the envisioned transformation of the 5G access network from a PBA to an SBA, the N2 interface (which connects the RAN to the Core Network) is used as an illustrative use case. In the current architecture, the N2 interface relies on the NGAP, a tightly coupled protocol carrying signaling messages between the gNB and the AMF.

To enable a service-based paradigm, NGAP procedures can be refactored into independent, discoverable services with clearly defined APIs. Below, we describe the main services identified, summarizing their purpose within the 5G system.

1) Do all these services need to be implemented in an SBA?: The transition from a PBA to an SBA does not necessarily require a one-to-one mapping of all NGAP services into standalone services (see Table II). Instead, the SBA provides an opportunity to rethink and optimize the service model, by:

- **Consolidating related services**: For example, `ErrorHandlingService` might become an inherent capability of each individual service rather than a standalone service.
- **Eliminating obsolete or redundant procedures**: SBA may obviate the need for some signaling interactions through tighter integration, better context sharing, or more dynamic service discovery. For example, in a SBA, the generic NAS Transport procedure (i.e., `NasTransportService`), as defined in NGAP, may be considered obsolete in its current form. The underlying functionality (transporting NAS messages between UE and AMF) remains necessary but is better addressed through explicit, discoverable, and semantically rich services aligned with the SBA principles.
- **Enhancing granularity**: Conversely, certain services (like `MobilityControlService`) might be decomposed into finer-grained services to improve modularity and scalability.

Thus, while the fundamental functional objectives of NGAP must still be addressed in any architecture (e.g., registration, session management, mobility, etc.), SBA allows more flexible ways to implement and expose these capabilities, enabling better support for flexibility, scalability, openness, and automation in 6G networks.

A possible realization of such an SBA-based architecture, as illustrated in Figure 3, introduces specific service producers and consumers that map NGAP functional objectives into modular, discoverable services. In this architecture, the UE represents the end-user equipment connecting to the RAN through the SAF, which acts as a proxy between the UEs and the RAN service bus, enabling seamless service discovery and invocation. Core RAN functionalities are exposed as independent service modules: the RAN Mobility Function (RMF) provides the `MobilityControlService`, the RAN Session Control (RSC) handles the `PduSessionService`, the RAN Context Manager (RCM) supports the `ContextManagementService`, and the RAN Status Reporter (RSR) consolidates and exposes status-related updates, including configuration, overload notifications, location reporting, and trace management.

Additionally, the RAN–CN module acts as a decoupling and mediation layer between the RAN and CN service buses, ensuring interoperability and smooth integration between them. It is important to note that this example specifically focuses on services exposed over the N2 interface, which handles control-plane interactions between the RAN and CN, and does not represent the full set of services in which the RAN is involved.

2) Comparative Analysis of UE Context Setup in Protocol-Based and Service-Based RAN Architectures: The UE Context Setup procedure undergoes a significant architectural evolution when transitioning from a traditional protocol-based 5G RAN to a service-based RAN design. In the current protocol-based model (see [6]), the procedure involves tightly coupled signaling exchanges among the gNB-DU, gNB-CU, and the AMF, primarily leveraging standardized interfaces such as F1 Application Protocol (F1AP) and NGAP. As depicted in Figure 2, this model requires detailed message coordination across multiple protocol layers and interfaces.

Conversely, the service-based RAN architecture simplifies and abstracts the procedure, as shown in Figure 5. Here, network functions such as the RAN Control Manager (RCM) and the SAF operate as loosely coupled services. The UE Context Setup is initiated by the AMF and orchestrated through modular service interactions, enabling dynamic function invocation and improved flexibility. This abstraction reduces protocol overhead and fosters scalability through a cloud-native, microservices-based design.

Conversely, the service-based RAN architecture simplifies and abstracts the procedure, as shown in Figure 5. Here, network functions such as the RAN Control Manager (RCM) and the SAF operate as loosely coupled services. The UE Context Setup, initiated by the AMF after the initial RRC connection is established, is orchestrated through modular service interactions, enabling dynamic function invocation and improved flexibility. This abstraction reduces protocol overhead and fosters scalability through a cloud-native, microservices-based design. It also manages the dynamic association between UEs and SAF, responsible for maintaining the radio connection, which may change due to mobility. As the SAF does not perform Radio Resource Management (RRM) tasks, a dedicated control module, similar in role to a near-RT RIC, can be introduced to handle radio-related tasks.

V. CONCLUSION

This paper has demonstrated the feasibility and benefits of extending the Service-Based Architecture (SBA) from the 5G Core to the Radio Access Network (RAN). By successfully redesigning two exemplary network procedures, we have shown the practical implications of this architectural shift. The adoption of the SBA in the RAN paves the way for a more modular, flexible, and software-driven network, making it a foundational evolution for the upcoming 6G network.

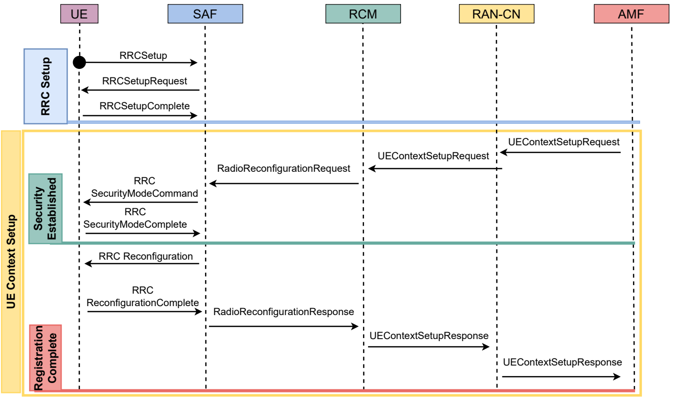

Fig. 5. Service-Based UE Context Set Up procedure example

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REFERENCES

[1] L. E. Chatzieleftheriou, M. Gramaglia, A. Garcia-Saavedra, S. Gebert, G. Garcia-Aviles, S. Geissler, M. Fiore, P. Patras, A. Lutu, D. Tsolkas, and M. A. Rahman, “Towards 6G: Architectural Innovations and Challenges in the ORIGAMI Framework,” in *2024 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)*, 2024, pp. 1139–1144.

[2] RESTART Consortium, “Restart – research and innovation on future telecommunications systems and networks,” https://www.fondazione-restart.it/, 2025, accessed: 2025-07-15.

[3] 3rd Generation Partnership Project (3GPP), “Technical Specification Group TSG SA; Study on 6G Use Cases and Service Requirements;Stage 1 (Release 20),” 3GPP, 3GPP TS 22.870 v0.3.1, Jun. 2025, available: https://www.3gpp.org/DynaReport/22870.htm.

[4] ——, “NR; Radio Resource Control (RRC); Protocol specification,” 3GPP, 3GPP TS 38.331 v18.6.0, Jun. 2025, available: https://www.3gpp.org/DynaReport/38331.htm.

[5] ——, “NG-RAN; NG Application Protocol (NGAP),” 3GPP, 3GPP TS 38.413 v18.6.0, Jun. 2025, available: https://www.3gpp.org/DynaReport/38413.htm.

[6] ——, “NG-RAN; Architecture description,” 3GPP, 3GPP TS 38.401 v18.6.0, Jun. 2025, available: https://www.3gpp.org/DynaReport/38401.htm.