SAPC: Ericsson's convergent policy controller

Deploying policy servers to add intelligence and control to the network not only boosts revenues but also lowers total cost of ownership.

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By implementing policy control, network service providers can guarantee bandwidth for higher-revenue services, allow market segmentation, assure fair usage of the network, stop or reduce services that degrade network performance, and guarantee optimum end-user experience.

Traditional policy control offerings have been divided into two categories: wireless and wireline products. Now, however, network service providers can employ a single core network to manage multiple access methods, and policy control has evolved to reflect this.

Ericsson's new Service-Aware Policy Controller (SAPC) will be a valuable asset to network service providers – wireless, wireline or both – who implement IP and broadband next-generation networks and service portfolios.

Telephone networks have evolved from dedicated links used mainly for narrowband telephony applications to a common broadband network, the resources of which are shared by a multitude of end users who compete with one another for quality of service (QoS).

In this new context, network service providers are striving to provide a high-performance network that delivers highly rewarding multimedia experiences, encourages long-term customer loyalty, and supports market-differentiating services.

Policy control plays a pivotal role in regulating this new reality.

Policies are configured in the policy controller node, which is situated between the service and transport domains. By managing the network from this location, network service providers can align service needs with the transport network. In addition, the introduction of subscriber- and service-aware control gives network service providers the ability to optimize network performance.

The way to convergence

Network service providers who manage wireline as well as wireless networks stand to benefit from convergence. Policy control offerings from vendors are approaching a one-size-fits-all model that will yield benefits in the form of better-optimized networks with simpler architectures and reduced maintenance costs.

As a step towards minimizing costs and network complexity, network service providers should assess the wireline and wireless network domains to identify synergies and redundant functions. Standardization in this area

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BOX A **Terms and abbreviations**

AAA	authentication, authorization and accounting	IP-CAN	IP connectivity access network	RACS	resource and admission control system
AF	application function	LDAP	lightweight data access protocol	RADIUS	remote authentication dial-in user service
A-RACF	access resource admission control function	MAE	multi-access edge		
		MBR	maximum bit rate		
AVP	attribute value pair	MSER	multi-service edge router	RCEF	resource control enforcement function
BRAS	broadband remote access server	MSISDN	mobile subscriber ISDN name		
CLIPS	call line identification presentation	NAI	network address identifier	SAPC	Service-Aware Policy Controller
		NetOpPM	Network Operation – Policy Management		
CoA	change of authorization			SASN	service-aware support node
CPG	converged packet gateway	PCC	policy and charging control	SGSN	serving GPRS support node
DPI	deep packet inspection	PCEF	policy and charging enforcement function	S-GW	serving gateway
DSLAM	DSL access multiplexer			SOAP	simple object access protocol.
EPC	evolved packet core	PCRF	policy and charging rules function	SPR	signal processor
E-UTRAN	enhanced UTRAN	P-CSCF	proxy call session control function	SQL	structured query language
GGSN	gateway GPRS support node	PDF	policy decision function	UAAF	user access authorization function
IMSI	international mobile subscriber identity	PDN-GW	packet data network gateway		
		PoC	proof of concept	VSA	vendor-specific attribute

has led to the approach defined by the 3rd Generation Partnership Project (3GPP), which employs a single core network to manage multiple access methods.

Where policy control is concerned, network service providers can configure a single "box" to apply common policies to the wireline and wireless domains. This allows for seamless end-user movement from the wireline network to the wireless network (or vice versa), and sets the stage for true multi-access networks.

Convergence also provides a strong value proposition, by reducing total cost of ownership (TCO) and introducing new revenue streams via a future-proof investment.

Reduced TCO
TCO is reduced by lowering capital expenditures (CAPEX) and operating expenses (OPEX). With converged policy control, network service providers can use common functions and processes to control multiple access methods. Having shared or common hardware means there are fewer "boxes" in the network, and represents a step toward making the converged policy controller the primary node for centralized administration and control. Likewise, having a unique subscription profile helps to maximize operations efficiency.

New revenue streams
Being able to control a network with wireline and wireless services from a single point opens the door to new business opportunities. One immediate benefit is enhanced user experience: when subscribers move between network access types – digital subscriber line (DSL) and high-speed packet access (HSPA), for example – the network behaves in the same way in terms of QoS, services allowed and so forth.

Other benefits of convergence include bandwidth management with convergent deep packet inspection (DPI), and common quota management with redirection to a top-up portal.

Future-proof investment
Consolidation and network simplification are logical progressions with regard to managing multiple types of access. Furthermore, they are in step with

FIGURE 1 Converged policy control for network service providers offering wireless and wireline access.
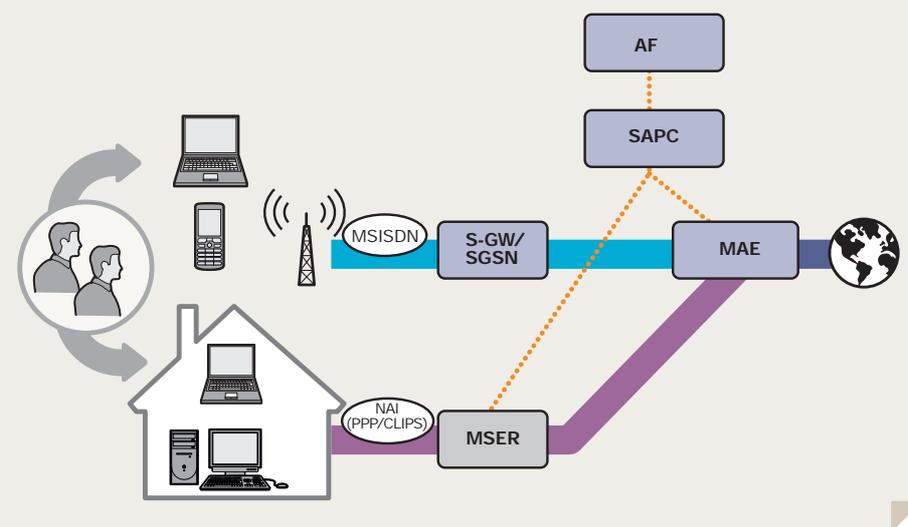
other developments relative to service provider networks and services.

Market view and vision
The market for policy control is very active, especially for wireless access following the introduction of mobile broadband. Today, with advanced new mobile terminals and good tariff plans, end users are increasingly likely to use their mobile devices to access the new services via the Internet. But since radio network capacity is a finite resource, limitations of some kind need to be enforced. By applying fair-usage policies, network service providers can minimize end-user abuse by the 10 percent of subscribers who consume 90 percent of network resources.

Throttling, which limits throughput, controls capacity as data traffic increases. Other offerings include a variety of unlimited mobile broadband price plans, such as post-paid (flexible price plans), pre-paid (pay-as-you-go, or volume or time vouchers), and throttling buyout offers.

These plans can be made more visible and attractive to end users, for example, via notifications or redirections to a web portal.

The inclusion of a policy server in the network can significantly increase revenues for network service providers, and

analysts anticipate a strong market for policy control solutions.

Ericsson's work in the field of policy control is fully aligned with current standardization efforts. 3GPP Release 8 (Rel-8), for instance, is a system that supports multiple kinds of access. In the system architecture, the core network hosts the anchor point (a packet data network gateway or PDN-GW) for these access types. A network edge element (the multi-access edge or MAE) provides connectivity to the internet, in addition to supporting a diverse set of services.

However, 3GPP Rel-8 is only the initial step toward achieving a complete multi-access network. It does not, for instance, specify how wireline access should be included.

Ericsson's position is that a policy controller, such as its SAPC, is needed to create a seamless central control point in the network. This approach provides all the required functionality coming from both wireless and wireline access **(Figure 1)**.

Proof-of-concept prototype
The first step toward realizing a converged SAPC product is to create a proof-of-concept prototype. Integrating software components of the Network Operation – Policy Management (NetOp PM) into the SAPC product, ▶▶

Convergent policy control from concept to product

FIGURE 2 Wireless access policy control.
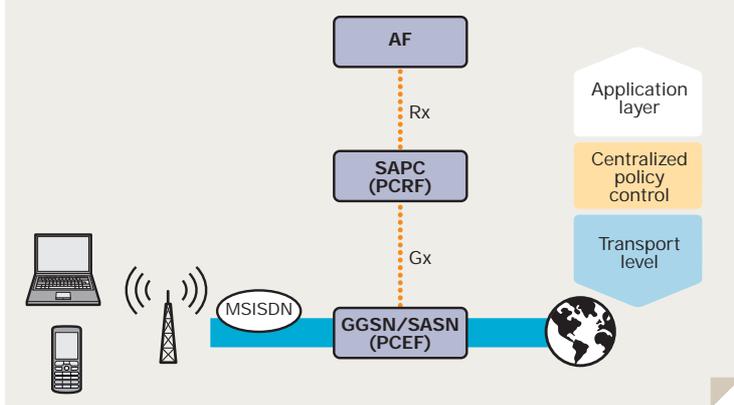
▶▶ Ericsson's prototype demonstrates the flexibility of SAPC to perform policy and charging control (PCC) across wireline and wireless access. The prototype is fully compliant with the 3GPP PCC architecture, implementing the policy and charging rules function (PCRF), and standard *Gx* and *Rx* interfaces.

The *Gx* interface enables standardized integration between DPI and the PCRF. In 3GPP Release 7 (Rel-7), the *Gq* interface (TS 29.207) defined in 3GPP Release 6 (Rel-6) (between the proxy call session control function or P-CSCF and the policy decision function or PDF) was replaced by the updated *Rx* interface, which introduced the PCRF and encapsulated the PDF.

Serving in the role of a PCRF, the SAPC provides PCC. The policy decisions it generates are communicated to the gateway, typically a gateway GPRS support node (GGSN), by means of PCC rules through the *Gx* interface.

One of the policy controls defined in the 3GPP PCC architecture is QoS control **(Figure 2)**. The policy and charging enforcement function (PCEF) – for instance, the GGSN or service-aware support node (SASN) – enforces the authorized QoS for an internet protocol-connectivity access network (IP-CAN) bearer according to information received via the *Gx* interface, and the bearer establishment mode.

In keeping with the architecture, the SAPC prototype also integrates new functionality for wireline access. Specifically, it implements a subset of the access resource admission control function (A-RACF) defined in the TISPAN standard **(Figure 3)**.

Serving in the role of an A-RACF, the SAPC provides resource reservation admission control and network policy control. The policy decisions it generates are communicated to the resource control enforcement function (RCEF) – typically a multi-service edge router (MSER) by means of remote authentication dial-in user service (RADIUS) attributes through a RADIUS change-of-authorization (CoA) interface. The MSER, which serves as a broadband remote access server (BRAS), sits at the edge of an ISP network, where it aggregates and controls user sessions from the access network.

Examples of the control the SAPC applies to user sessions include QoS policy control and portal redirects. Control can be based on a variety of conditions, including subscription profile, time of day and usage.

The prototype includes RADIUS accounting proxy functionality, which allows a converged node between a BRAS and a carrier's authentication, authorization and accounting (AAA) node to support convergent usage control and policy control. With this network architecture, the SAPC can, when it receives an accounting start, stop, or interim message, detect when user sessions have been established, terminated or changed.

Session establishment in the MSER triggers an evaluation process in the SAPC. The outcome of this evaluation is a set of policy control parameters to be applied to the session via a RADIUS CoA message.

The SAPC component makes policy decisions for wireline and wireless accesses, providing a centralized control that is based on a single subscription. The SAPC maintains one subscription that associates different subscriber access identities (mobile subscriber ISDN name or MSISDN, international mobile subscriber identity or IMSI, and network address identifier or NAI) to a single subscription or administrative identity.

Users are treated as part of an offering or group according to their subscription references. For example, they could be divided into Gold, Silver and Bronze groups for all the types of access they are granted. In the case of a Gold user,

FIGURE 3 Wireline access policy control.
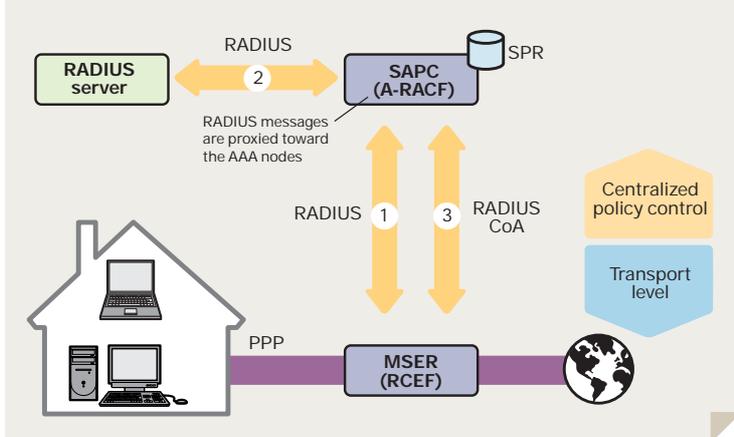
the SAPC would keep a Gold plan and tie Gold policies to all (enforcement) nodes through which the user's traffic passes. These policies could authorize the same services and QoS in the wireline and wireless access types, or they could differentiate services and QoS based on the user's access type **(Figure 4)**.

The SAPC also supports fair usage functionality by extracting wireline and wireless access information. Reports about wireless access usage are received through the *Gx* interface; wireline access usage is conveyed via RADIUS accounting messages.

The SAPC collects the reported volume in a user accumulation counter that permits control of subscriber usage and allows for actions to be taken when subscribers exceed their usage limits. Examples of actions are restricting access, downgrading QoS, redirecting, declining sessions, and notifying the subscriber via text message or e-mail.

The SAPC supports common accumulators for use with both wireline and wireless access. These accumulators can be configured to apply end-user limits to all types of access or different limits to different types of access **(Figure 5)**.

SAPC demonstration at Mobile World Congress

Ericsson gave a live demonstration of the SAPC at the Mobile World Congress 2010 in Barcelona. The demonstration involved a subscriber able to access the network from both a wireless and a wireline access network. During the demonstration, the subscriber initiated concurrent wireline and wireless sessions. The SAPC first evaluated session and user subscription data. It then sent policy decisions to the enforcement points – for wireline access, the SmartEdge router; for wireless access, the GGSN and SASN.

The first case demonstrated a user in the Gold group. This category of users is entitled to high QoS over both wireline and wireless accesses. During the course of the sessions, the user subscription was reassigned (through the GUI) to the Silver group. This change called for reauthorization in the SAPC, which then communicated a QoS downgrade to both accesses. The effect of the downgrade could be seen in the monitoring PCs.

The second use case demonstrat- ▶▶
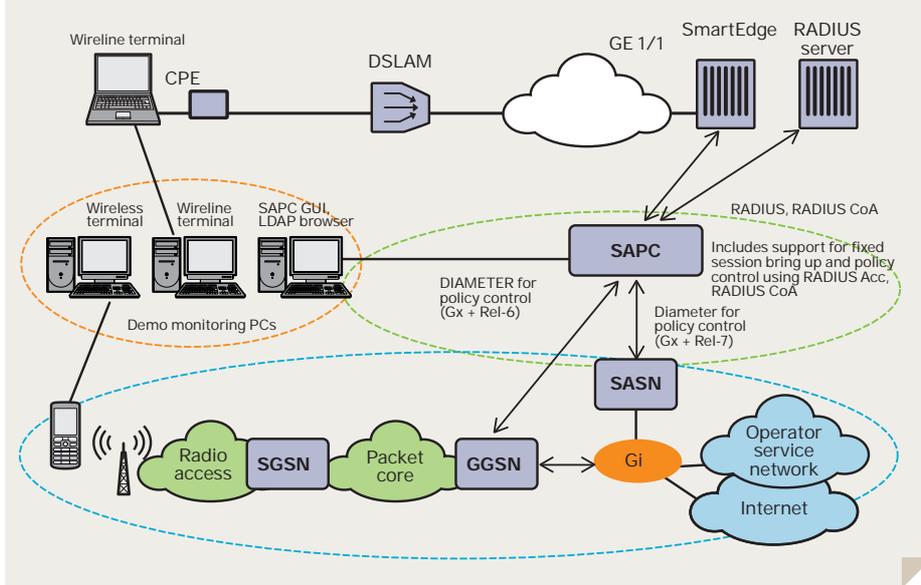

FIGURE 4 Converged policy control.
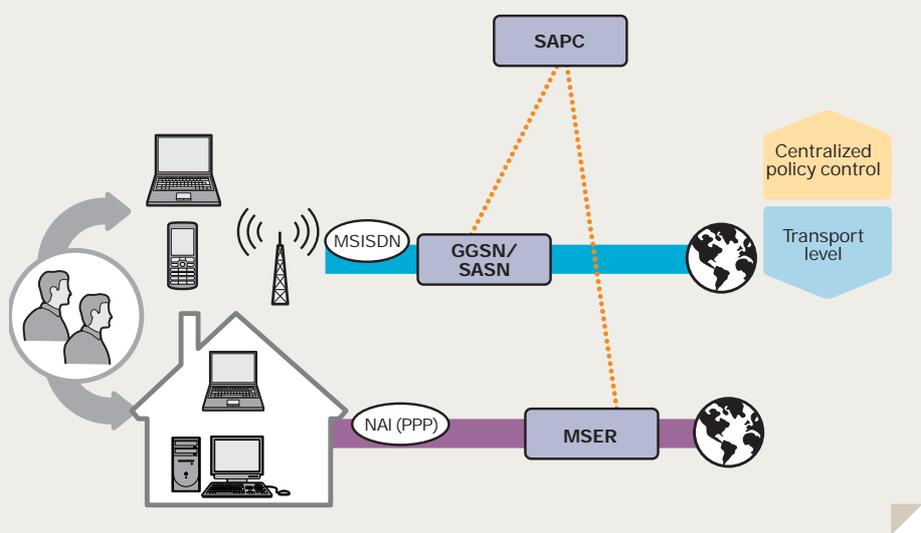
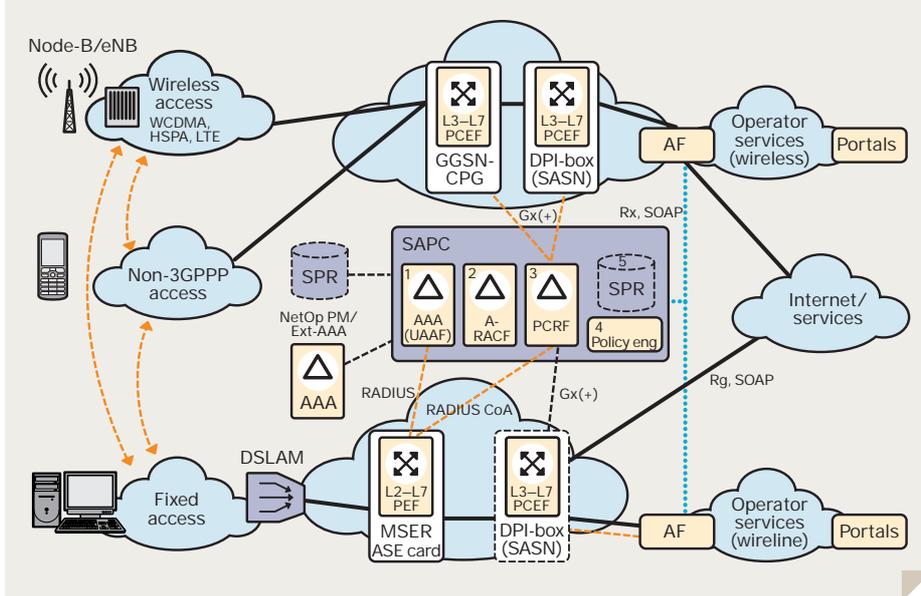
FIGURE 5 Converged usage control.
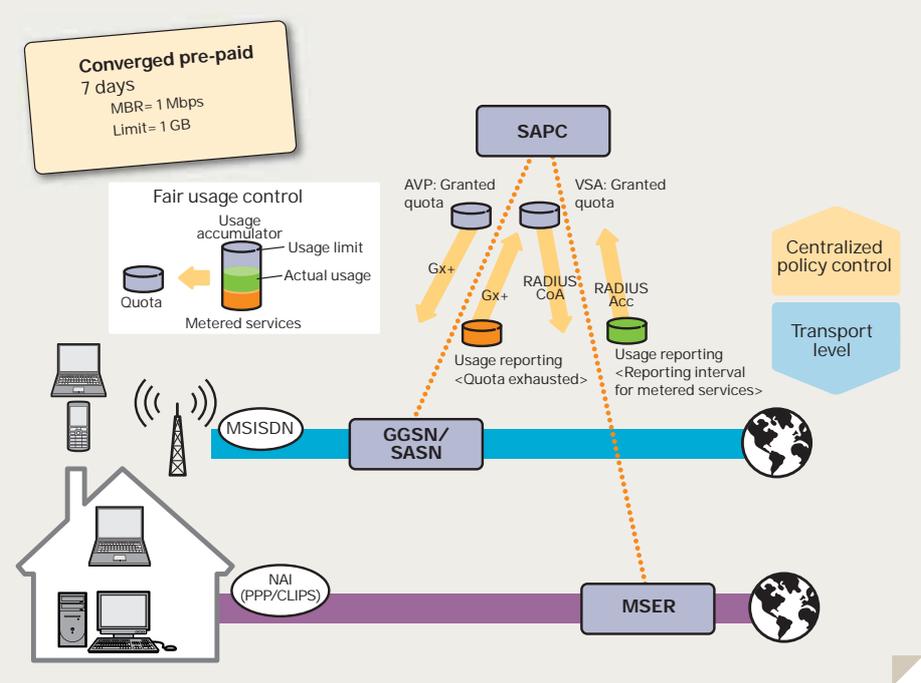
FIGURE 6 Demo infrastructure.

FIGURE 7 Internal architecture and reference model.

ed fair usage. The subscriber in this demonstration initiated concurrent wireline and wireless sessions. During the course of the sessions, the SASN and the gateway reported usage data to the SAPC.

The user had a subscription to a wireline-wireless plan with a data usage limit of 10GB – wireline, wireless or both. After reaching this limit, the subscriber was redirected to a web portal where the quota could be topped up.

The infrastructure for the live demonstration consisted of the following parts:

- A radio access network and a mobile packet core network where the SAPC received usage reports about wireless user sessions from a DPI node (SASN). The SAPC then sent policy decisions to the SASN and GGSN, where they were enforced.
- A fixed access network that comprised
  - customer premises equipment (CPE) – in this case, end-user workstations and an asymmetric DSL or ADSL modem;
  - a DSL access multiplexer (DSLAM), which collected traffic from multiple subscribers into a centralized point;
  - a SmartEdge router, which served as a BRAS, routing traffic to and from the DSLAM; and
  - a RADIUS server, to which the SAPC forwarded RADIUS requests received from the SmartEdge router.
- The SAPC, which served as the centralized policy decision point.
- PCs for monitoring usage and QoS of user sessions initiated from both access networks.
- An operation administration and maintenance (OAM) PC, which, via a lightweight data access protocol (LDAP) browser and graphical user interface (GUI), was used to provision and configure the SAPC.

Proof of concept becomes product

Given the success of the SAPC demonstration at the Mobile World Congress 2010, the next logical step is product commercialization.

Apart from incorporating new functional features, emphasis is put on operations and aspects of management. The objective is to give network service providers an easy-to-configure product that contains tools for collecting statistics

and detecting faults, and has the same look and feel for both wireless and wireline accesses.

The result is a solid product with a "friendly" GUI that allows flexible configurations according to network service provider needs.

In terms of architecture, the A-RACF, PCRF and AAA components share a powerful and flexible policy engine (Figure 7). The SAPC communicates with wireless and wireline access gateways using standard or *de facto* standard protocols. It also supports connection to the network application layer via standard protocols or using web service technology for easy integration with application functions that do not implement 3GPP or TISPAN protocols.

Web service technology may also be used with operation and maintenance (O&M) systems that do not support LDAP. The SAPC can support external or internal databases to store subscriber data (LDAP), structured query language (SQL), and extensible markup language (XML).

The converged approach gives added value. Examples include

- converged bandwidth control for wireless access, wireline access or both. This gives network service providers the tools to differentiate between user categories that can be defined across accesses; and
- converged fair usage control based on time, volume or both. This involves the ability to specify separate quotas per service or access type, or to define quotas common to both access types.

Other features include support for redirection to a web portal using flexible policies (for instance, manual authentication of an unauthorized user) and for notifications informing subscribers of events, such as consumption of a volume quota.

The functionality is key to give users information about their current options for extending the service when, say, a usage limit has been reached.

The SAPC can also serve in deployments that include only one access (either wireless or wireline), taking advantage of the features mentioned above, as well as of other access-specific features (by applying charging control or RAN congestion-avoidance mechanisms in wireless access types, for instance). ❖

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