Bridging non-standard positioning methods with standard positioning methods in cellular standards:

Opportunities and Challenges

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Highlights of decade of positioning improvements

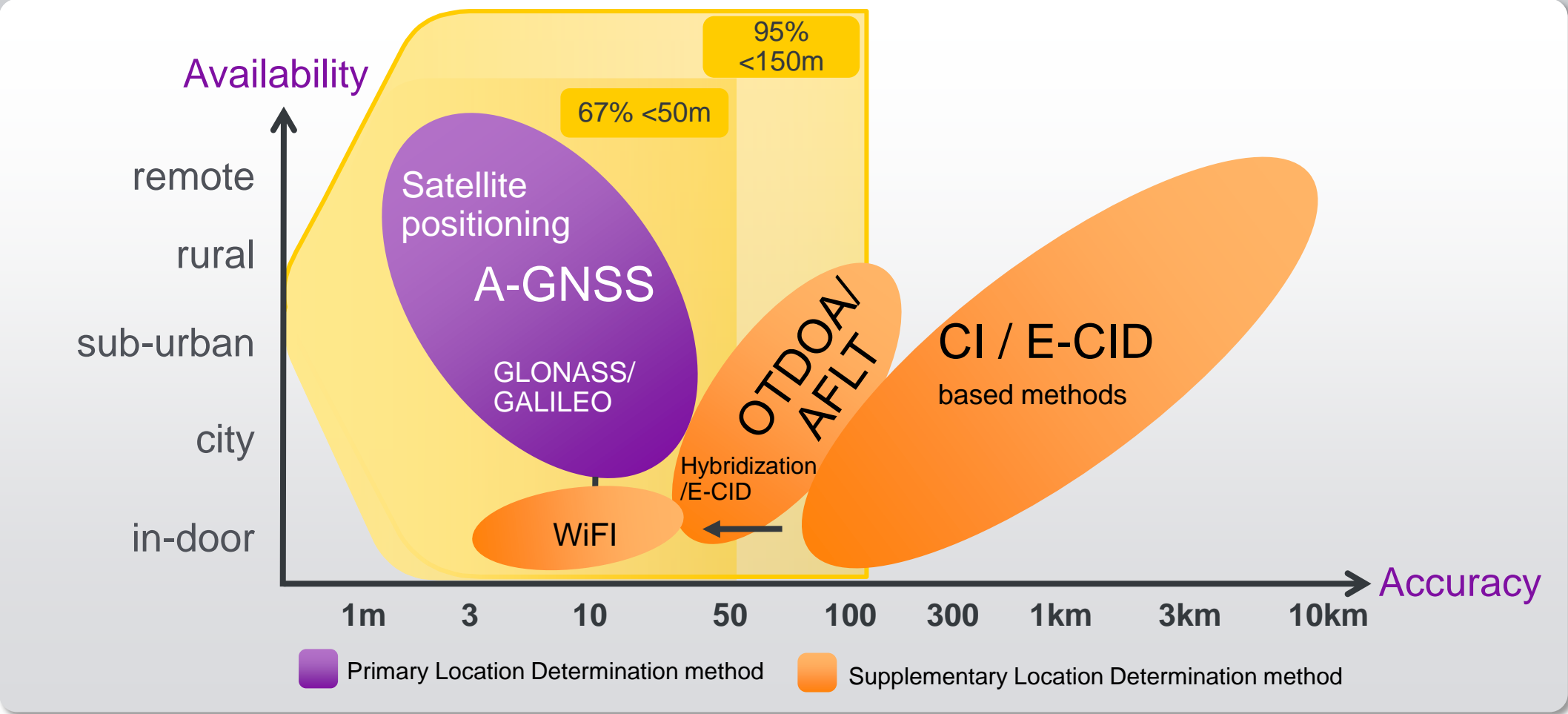| Primitive MT Cell ID	'Forced' E911Driven	LBS High Accuracy	Wider User Plane	Complete
INAP, MAP ATI, SIM TK, E911 Ph1,Pre-Standard (Control Plane)	Control Plane E911 Ph 2 MT A-GPS/ U-TDOA/AFLT	User Plane Qualcomm V1/2 OMA SUPL 1.0 (MT + MO)	SUPL 2.0 Emergency, Periodic/ Triggered Fix	Super-hybrid: trilateration+ A-GNSS+WiFi, DAS,Repeaters, Better Indoors
Early 2000s	**2000 onwards**	**2000s**	**Early 2010s**	**Ongoing**

Evolution of technology, standards and regulations drove position standards forward to satisfy business needs:

- Pre-Standard solutions evolve into Standardized solutions
- Necessary for interoperable multi-vendor solutions
- Standards reduced risk and cost for operators

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Sophisticated hybridation to improve accuracies of traditional positioning technologies:

Availability

- remote
- rural
- sub-urban
- city
- in-door

Satellite positioning A-GNSS

GLONASS/GALILEO

95% <150m

67% <50m

OTDOA/AFLT

CI / E-CID based methods

Hybridization /E-CID

WiFI

Accuracy

1m   3   10   50   100   300   1km   3km   10km

Primary Location Determination method

Supplementary Location Determination method
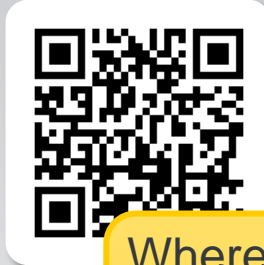
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Examples of different indoor positioning methods:

Where am I in Super Walmart ?

Where am I in the Louvre?

Where am I in the warehouse?

Workcube C-3-157

Where am I in the NSN campus?

But how do we integrate these into existing positioning systems for hybridation?

- Requires "local knowledge" and extensions beyond current positioning protocols.

- Let's look at a couple of standardized enablers

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What is a Discovered SUPL Server?

The D-SLP is a SUPL Location Server that is discovered by the SUPL Device.

The D-SLP is typically targeted at performing positioning in the vicinity of the Devices current location.

Procedures have been specified to discover the D-SLP and get authorization by the Home SLP to use the D-SLP.

The selection of D-SLP can be based on but not limited to conditions as access type, location and service type.

Originally a SUPL 3.0 feature, and recently also ported back into a SUPL 2 context within the SUPL 2.1 standard.

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Discovered SUPL Server - Opportunities

A D-SLP would typically be dedicated to serving specific (indoor) geographic areas:

- Examples include: a mall, a warehouse, an airport's terminals, a university Campus, an office complex….

- Has specific local data to aid positioning in those locations (local sensors, beacons, maps…)

- Can use standard and non-standard positioning technologies

Conceptually allows 3rd party D-SLP providers who are dedicated to indoor positioning.

- D-SLP service provider could provided to multiple carriers

- Avoids replication of data management and cost

- Some indoor information may be considered confidential

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Discovered SUPL Server - Challenges

- The amount of data involved.

- 3rd party providers getting their business off the ground.
    - DAS office service providers show a good analogous business model

- Carriers trusting outsourcing this capability (Security/Subscriber Privacy => SLAs)

- There may be arrangement between the provider of an Home-SLP and the provider of a D-SLP to avoid service overload to the D-SLP

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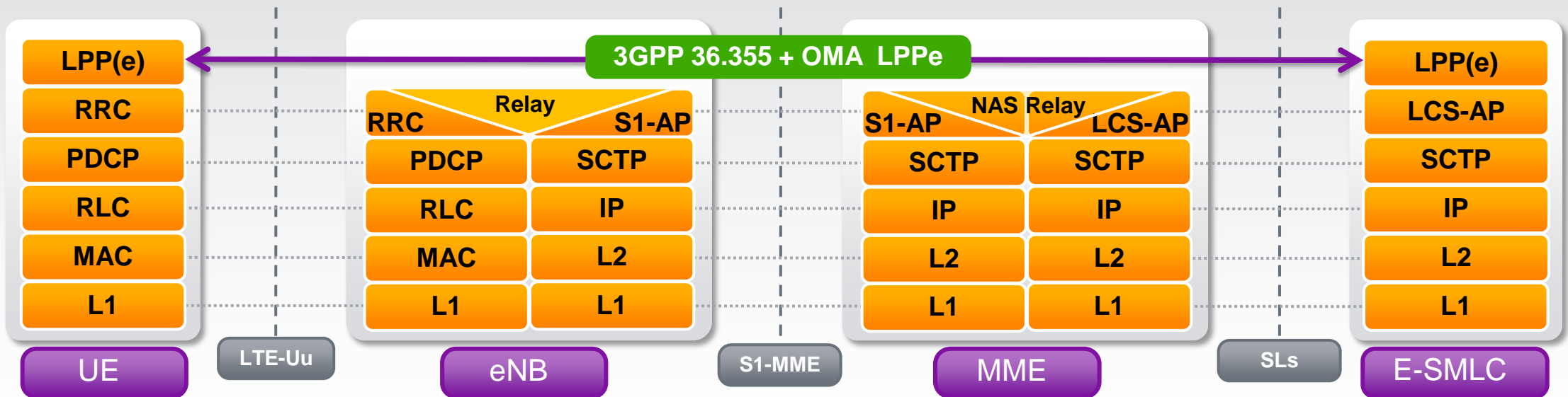
06 Closing Comments

What is LPPe?

LPP is the LTE Positioning Protocol specified in 3GPP 36.355

LPP has been designed in such a way that it can also be utilized outside the control plane domain such as in the user plane in the context of SUPL.

LPP elementary messages each include a container, an EPDU, which can be used by standardization fora outside 3GPP to define their own extensions to the LPP messages. Potentially carriers or vendors can add proprietary extensions.

For example, the OMA LPP Extensions (LPPe) take advantage of this option.

3GPP 36.355 + OMA LPPe

UE		eNB		MME		E-SMLC
LPP(e)		Relay		NAS Relay		LPP(e)
RRC		RRC / S1-AP		S1-AP / LCS-AP		LCS-AP
PDCP		PDCP / SCTP		SCTP / SCTP		SCTP
RLC		RLC / IP		IP / IP		IP
MAC		MAC / L2		L2 / L2		L2
L1		L1 / L1		L1 / L1		L1

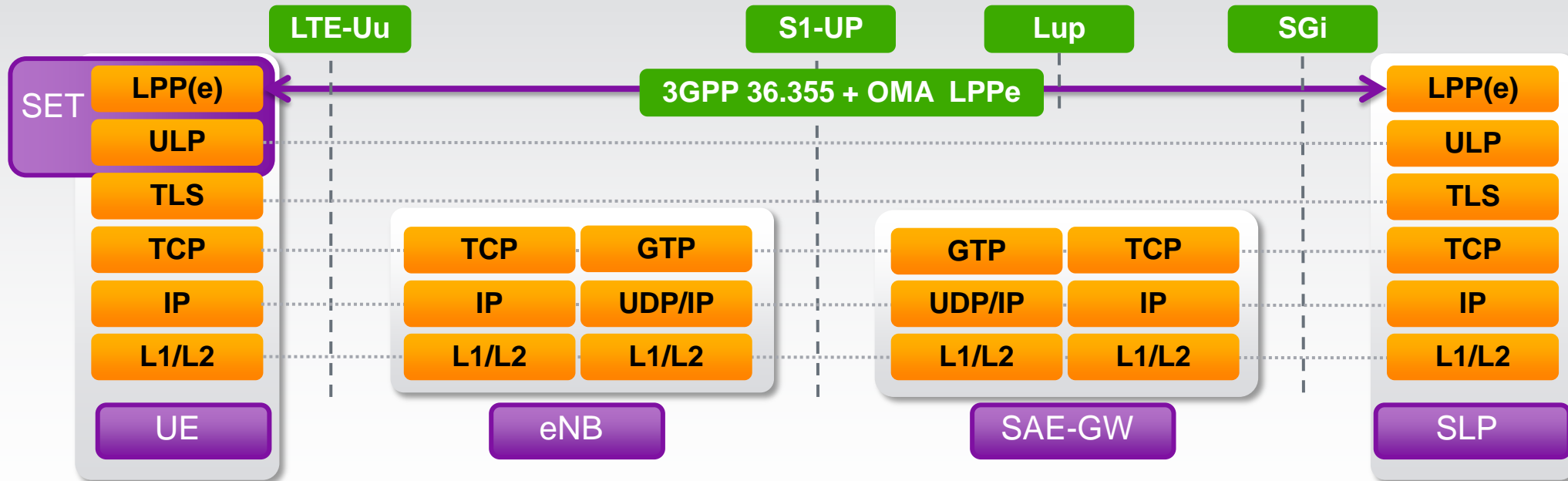LTE-Uu   S1-MME   SLs

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LPPe - Opportunities

OMA has specified LPPe on top of the 3GPP-defined LPP to allow:

- convergence of control and user plane positioning protocols (RRLP/RRC/LPP)
- reduced standardization work load, leverage off LPP framework
- being able to use the same LPPe protocol stack both in the control and user plane

Extensions enable the positioning of Users attached by a range of GSM, UMTS, LTE, Cable, DSL, LAN, WiMAX, etc connections and allow the full range of potential positioning techniques.

More opportunity to improve positioning accuracy (e.g. E911 Accuracy)

| LTE-Uu | S1-UP | Lup | SGi |

SET

LPP(e)		3GPP 36.355 + OMA LPPe		LPP(e)
ULP				ULP
TLS				TLS
TCP	TCP	GTP	GTP	TCP	TCP
IP	IP	UDP/IP	UDP/IP	IP	IP
L1/L2	L1/L2	L1/L2	L1/L2	L1/L2	L1/L2

| UE | eNB | SAE-GW | SLP |

Example: LPPe over SUPL LTE stack

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LPPe - Challenges

Complexities

- Supporting more indoor positioning technologies as they become available

- Lots more data to manage with new indoor positioning methods, to keep accurate and provision accurately

Compatible LPPe implementations

- Many LPPe options results in the challenge of deploying compatible LPPe implementations in Devices and Servers.

- Carriers have control over LPPe functionality in Servers.

- Big carriers have some control over devices used on their networks, and could define LPPe profiles that must be supported by their device vendors.

- Smaller carriers may have less control

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Summary

- Many new indoor positioning technologies are here and coming.
- Many require localization and protocol extensions.
- Two examples of how to enable these new indoor positioning technologies were presented:
    - Discovered SUPL Servers
    - LPP Extensions (LPPe)
- Both are part of the OMA Location standards.

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