5G포럼 교통융합위원회 백서 워크샵

C-V2X 기술 현황 Part 2

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자동차/교통 분야 트렌드

통신 수요 증가

다른 차량과 …

보행자와 …

도로 시설물과…

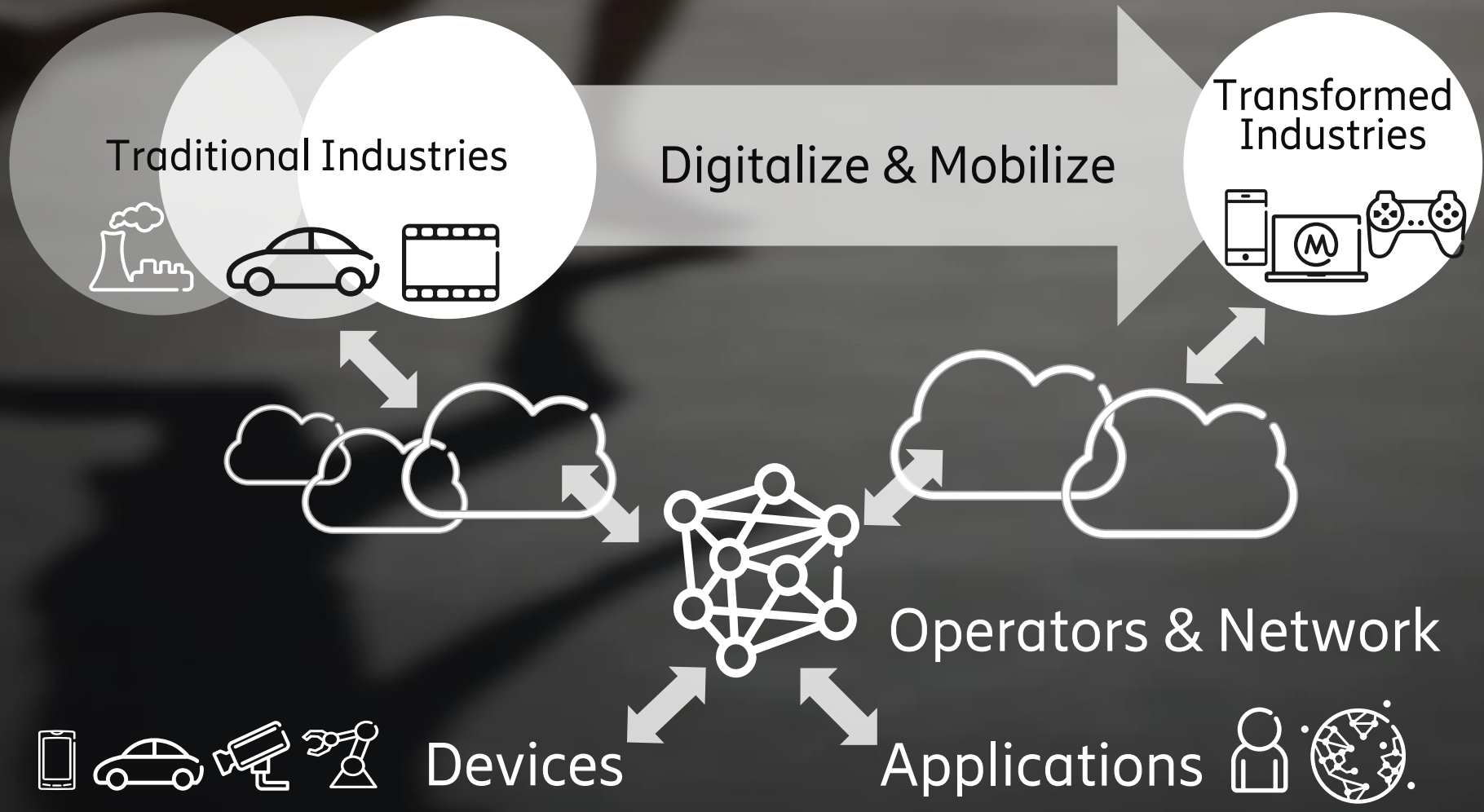
그리고 세상과…

Connected driving
- C-ITS (Basic/Advanced)
- Autonomous Vehicle

Traffic management
- Transportation
- Fleet management

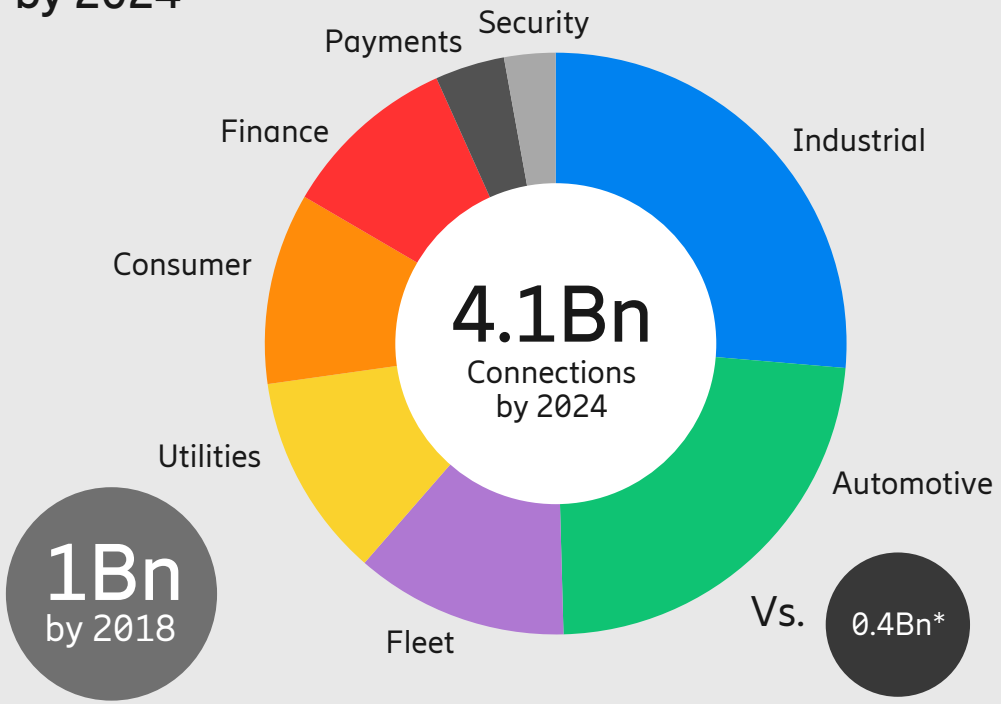
Infotainment

Industry transformation and 5G



Cellular IoT market outlook

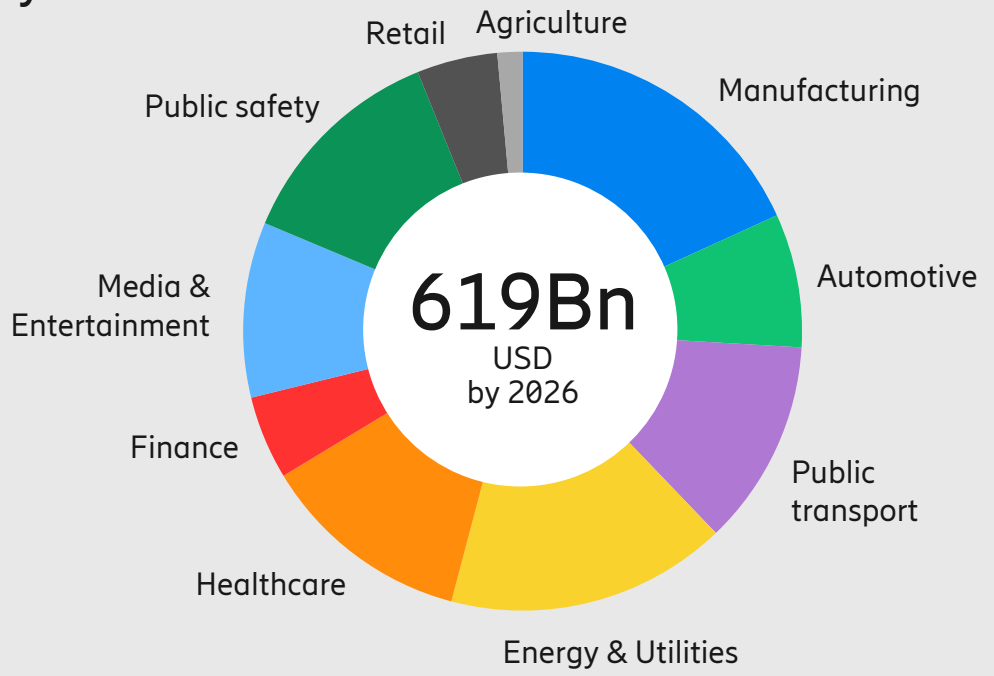
Cellular IoT connection by 2024



Source: Ericsson mobility report

*Wide Area non-cellular IoT connection by 2024

5G revenue potential from industry digitalization by 2026



Source: Ericsson and Arthur D Little's 5G revenue potential from industrial digitalization study

Massive IoT continues to evolve

- Cat-M
- NB-IoT

- Coverage extension
- Battery Life
- Low complexity devices
- Flexible deployment
- 5G ready

- Focus on wide area

- For all industries

Global adoption

>80 commercial networks in 40 markets
both NB-IoT & Cat-M1 for diverse use cases

5G technologies

Meet 5G performance and capacity
requirements fully co-existing with 5G NR

Ensured Long lifecycle

Replace legacy 2G technologies

Converged Requirements (LPWA)

Multiple Industries and Use cases

Utilities – Smart metering
Wearables – Health surveillance
Smart Cities – Smart sensors
Transport – Fleet management

Massive IoT solution

Managing fleets, Sensor sharing, Telematics

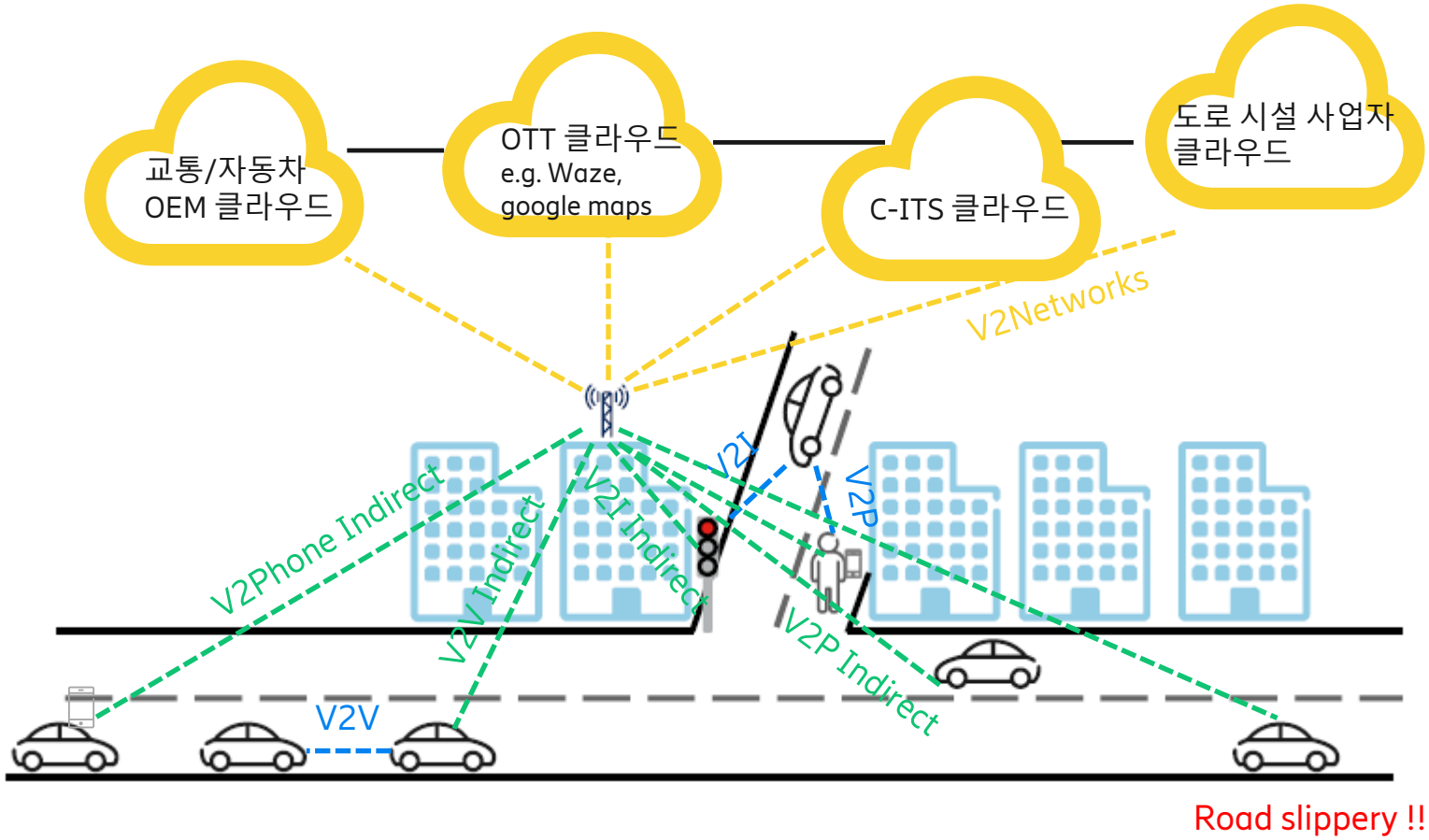
EC-GSM	**Evolution of GSM** Ultra-low bitrate applications
Cat-M1	**eMTC 1.4MHz** Low to medium bitrate applications
NB-IoT	**200KHz carrier** Ultra low-bitrate applications

Broadband IoT (LTE-based) => C-V2X

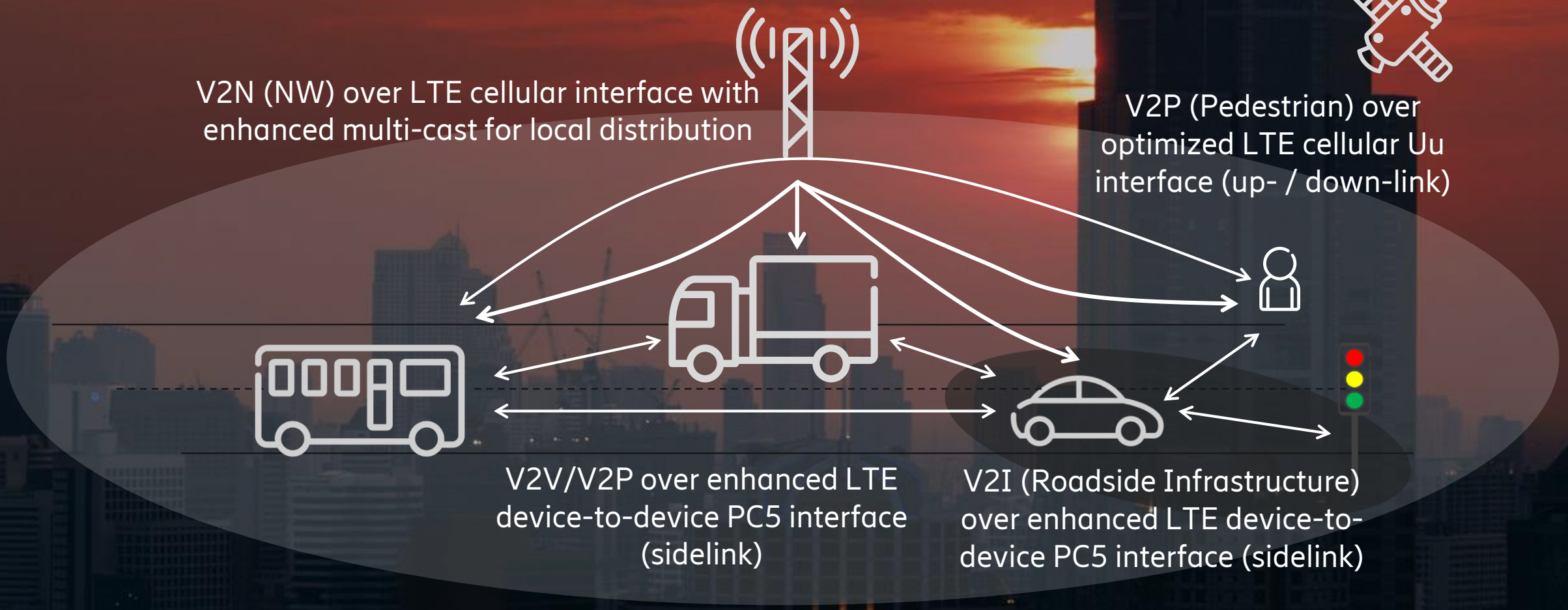
V2X 직접통신
(Direct links)

V2X 간접통신
(Indirect links)
— 원거리 통신, 효율성

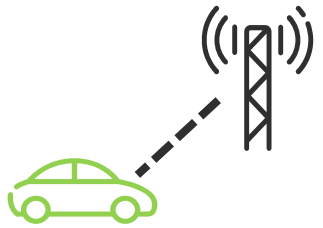
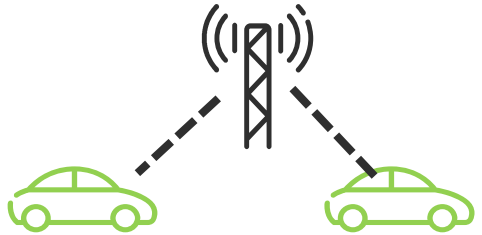
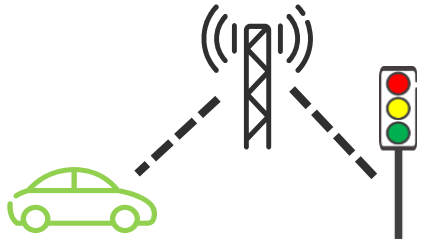
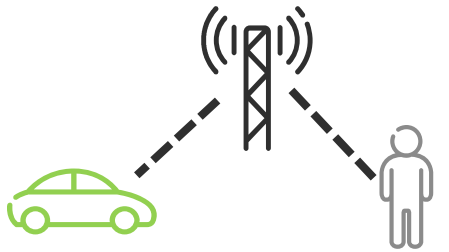
V2Networks
— 다양한 서비스 연결



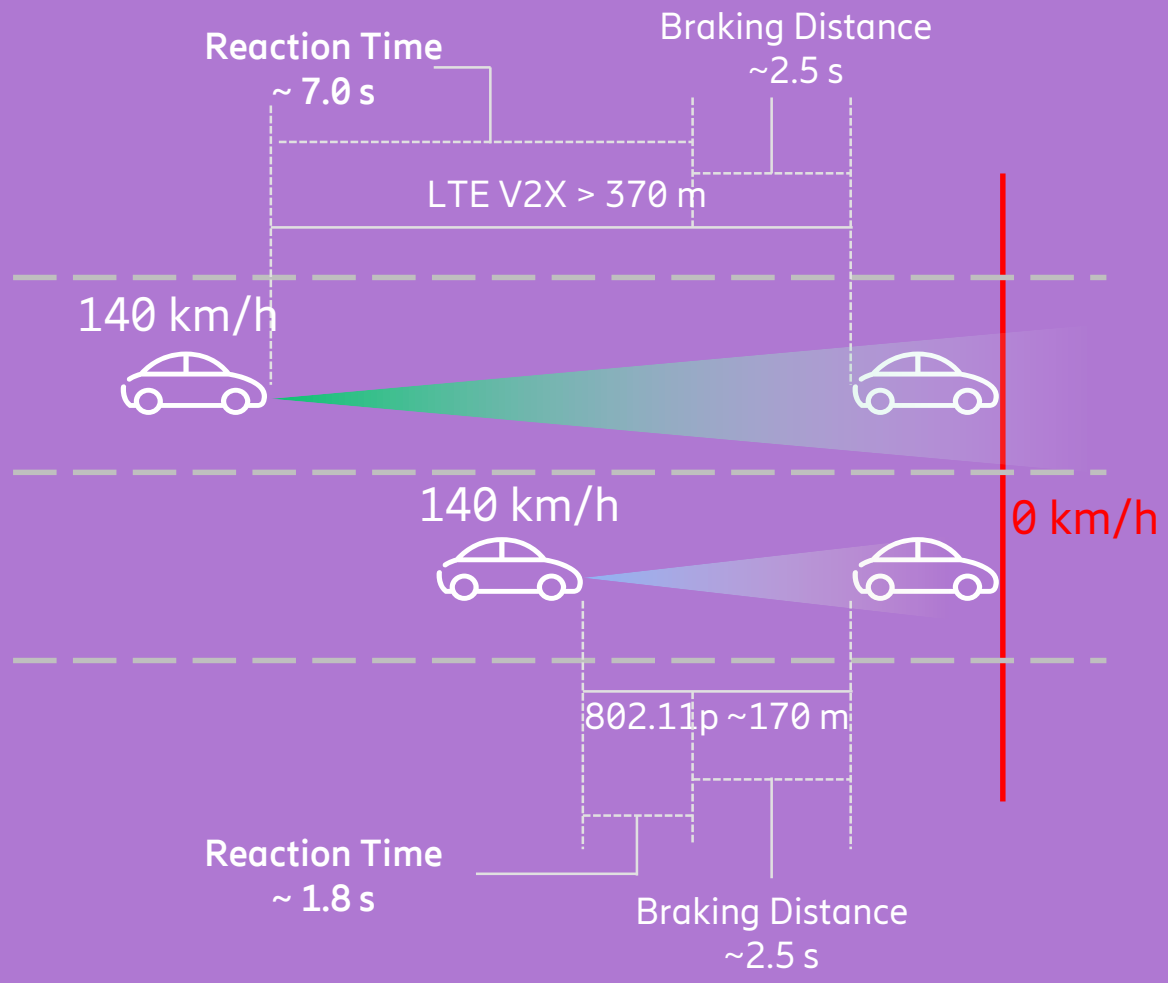
LTE-V2X 개요

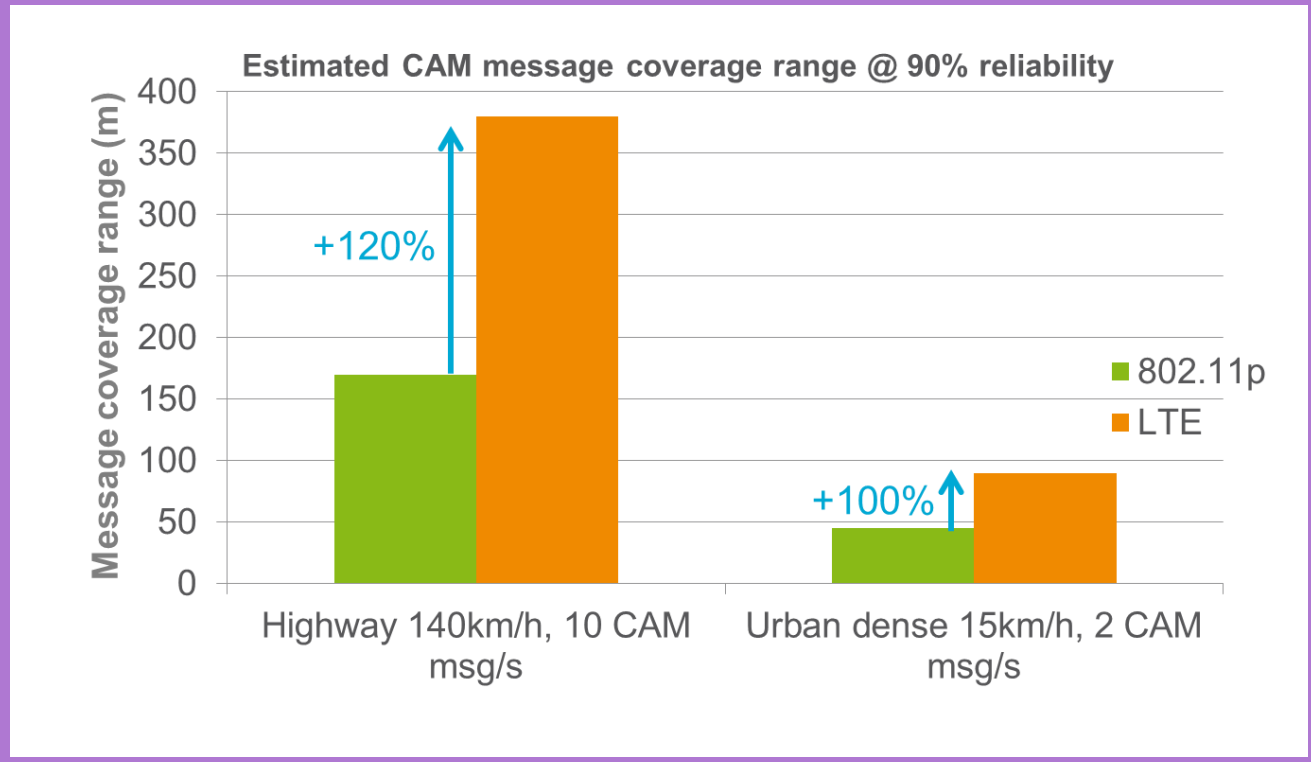

V2N (NW) over LTE cellular interface with enhanced multi-cast for local distribution
V2P (Pedestrian) over optimized LTE cellular Uu interface (up- / down-link)
V2V/V2P over enhanced LTE device-to-device PC5 interface (sidelink)
V2I (Roadside Infrastructure) over enhanced LTE device-to-device PC5 interface (sidelink)

Communication paths

	Direct (short range)	Indirect (via NW)
V2N Vehicle to Network		
V2V Vehicle to Vehicle		
V2I Vehicle to Infrastructure		
V2P Vehicle to Pedestrian		

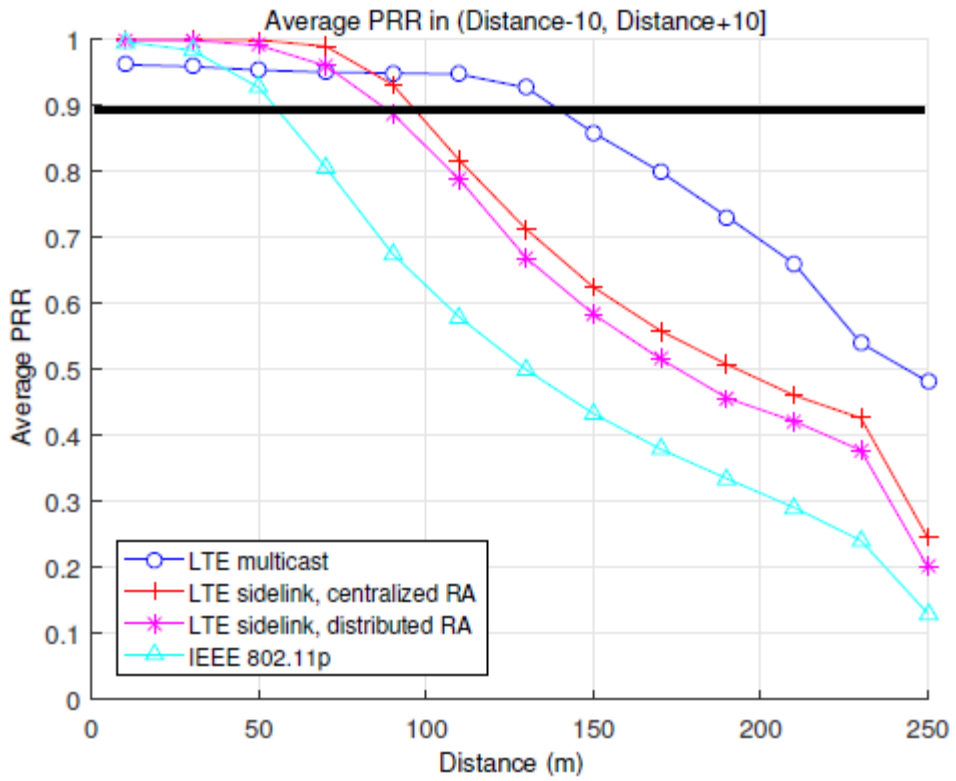
V2V Performance
LTE-V2X sidelink vs. IEEE 802.11p



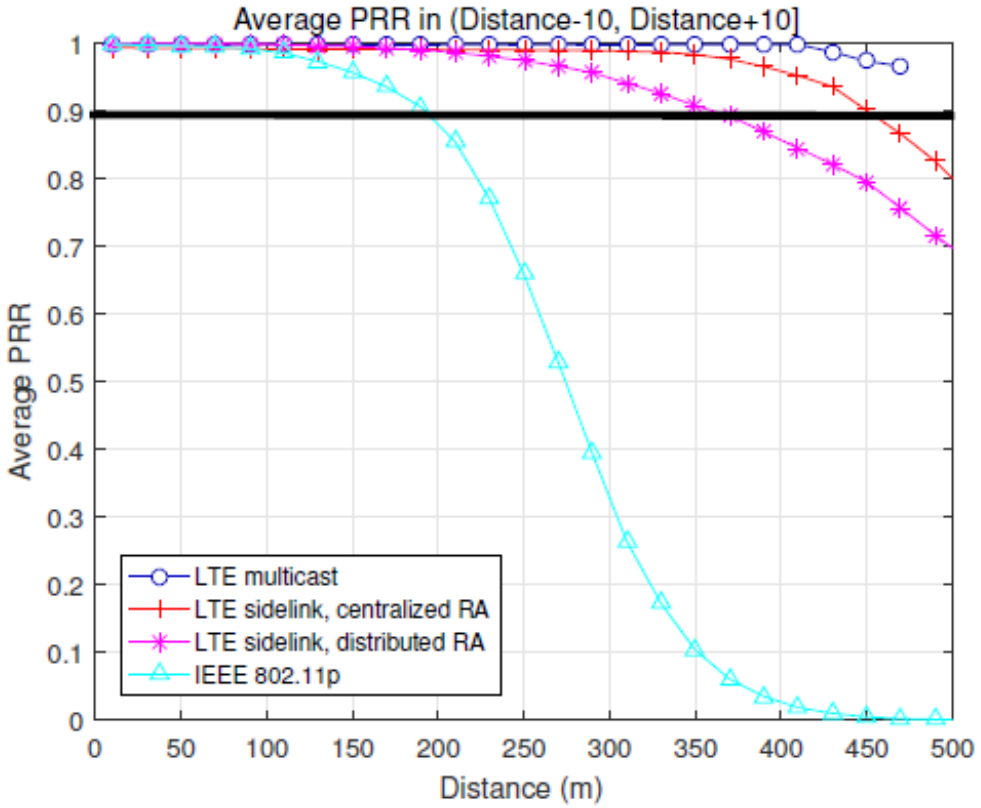


*R. Blasco, H. Do, S. Shalmashi, S. Sorrentino, Y. Zang, "3GPP LTE Enhancements for V2V and Comparison to IEEE 802.11p", EU ITS Congress 2016

V2X performance comparison



Average PRR at 175 vehicles/cell (15Km/h) in Urban Slow scenario at 5.9 GHz carrier

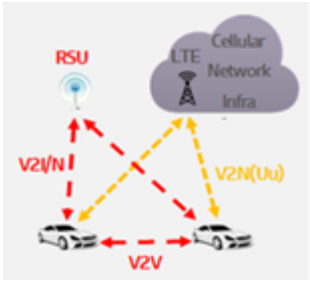


Average PRR at 54 vehicles/cell (140 Km/h) in Freeway Fast scenario at 5.9 GHz carrier

*Wang Min, et al., "Comparison of LTE and DSRC-Based Connectivity for Intelligent Transportation Systems", VTC Spring 2017

망 구축 방안 비교

1안: C-V2X + LTE(Uu)

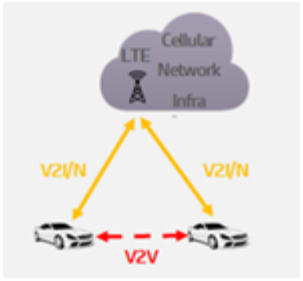


- RSU 설치로 교통정보 G/W 기능
- V2V: 5.9GHz C-V2X
- V2I: 5.9Ghz C-V2X
- V2N: LTE (infotainment)

- 저지연 교통정보 전송

- 다수 단말 시 간섭 (V2V/V2I 채널 공유 시) 커버리지 한계
- RSU 추가 투자비 발생

2안: C-V2X + LTE

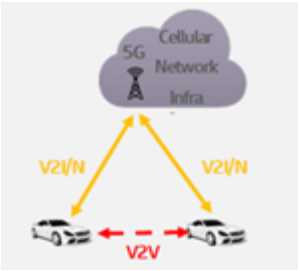


- LTE 망으로 C-V2X 일부 수용
- V2V: 5.9GHz C-V2X
- V2I/N: LTE (Infotainment + 교통)

- QoS 제어 및 보안성 향상
- RSU 추가 투자비 없음

- 교통정보 전송 시 추가 지연 발생 가능성 (1안 대비)

3안: C-V2X + 5G



- 5G 망으로 C-V2X 일부 수용
- V2V: 5.9GHz and/or mmWave C-V2X
- V2I/N: 5G (infotainment + 교통)

- 초저지연 (short TTI, edge cloud, network slice 적용)
- RSU 추가투자비 없음

- 적용시기 늦음

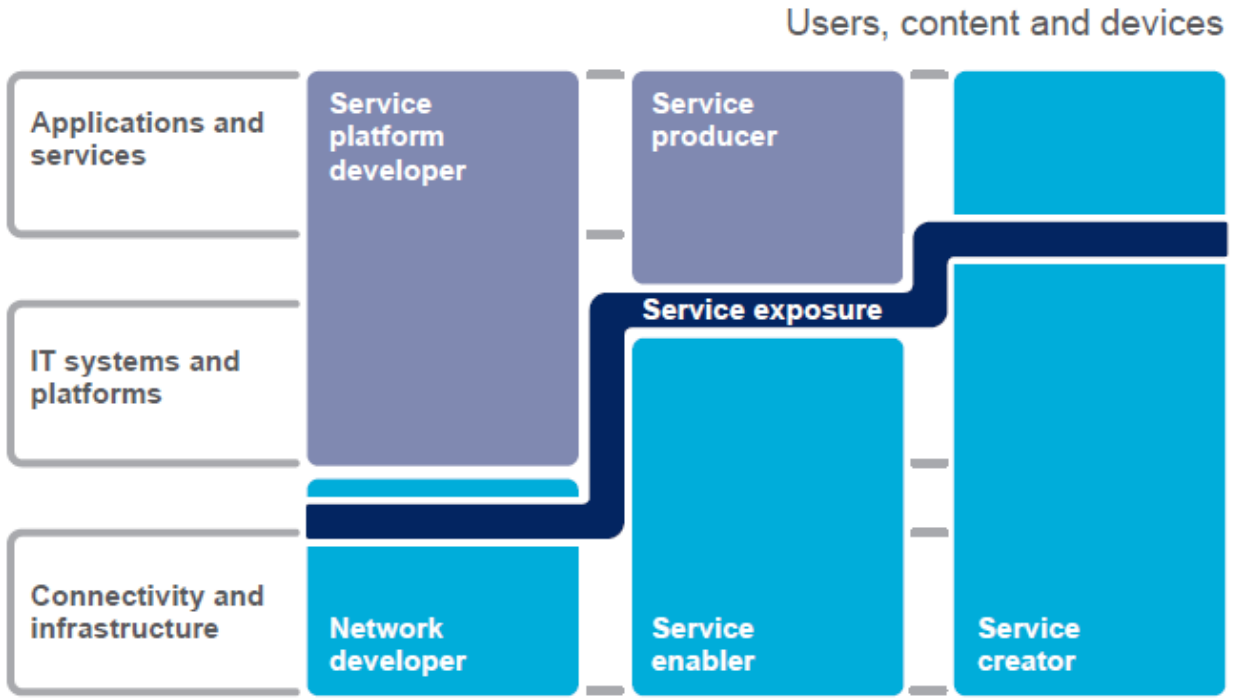
▪ ↔ : 공공 대역
▪ ↔ : 상용 대역

3GPP 5G 요구사항 (Critical IoT)

Peak data rate	DL: 20 Gbps UL: 10Gbps	UE battery life	10-15 years
Peak spectral efficiency	DL: 30 bps/Hz UL: 15 bps/Hz	UE energy efficiency	inspection (Qualitative)
Spectral Scalability	Yes	Cell/Tx Point/TRP sp. Eff.	3 x IMT-A requirement
Bandwidth	Reference to IMT-2020	Area traffic capacity	10 Mbps/m^2 [ITU]
Bandwidth Scalability	Yes	TRP spectral efficiency	3 x IMT-A requirement
Control plane latency	10 ms	User experienced data rate	100/50 Mbps DL/UL [ITU]
UP latenc URLLC, one-way	0.5 ms	User sp. Eff. At 5% percentile	3 x cell edge IMT-A requirement
UP latency eMBB, one-way	4 ms	Connection density	1,000,000 devices/Km^2
Latency for infrequenct small packets	10s / 20 byte packet	NW energy efficiency	Qualitative & Quantitative KPI
Mobility interruption time (intra-syst.)	0 ms	eMBB Extreme coverage	140/143 dB loss MaxCL (2/1(DL))
Mobility	Up to 500 Km/h	IoT Coverage	MCL 164 dB for 160 bps
Inter-system mobility	Yes	Support of wide range of services	Yes
Reliability (URLLC)	1-10^{-5} in 1ms	Reliability (eV2X)	1-10^{-5} in 2-~10 ms

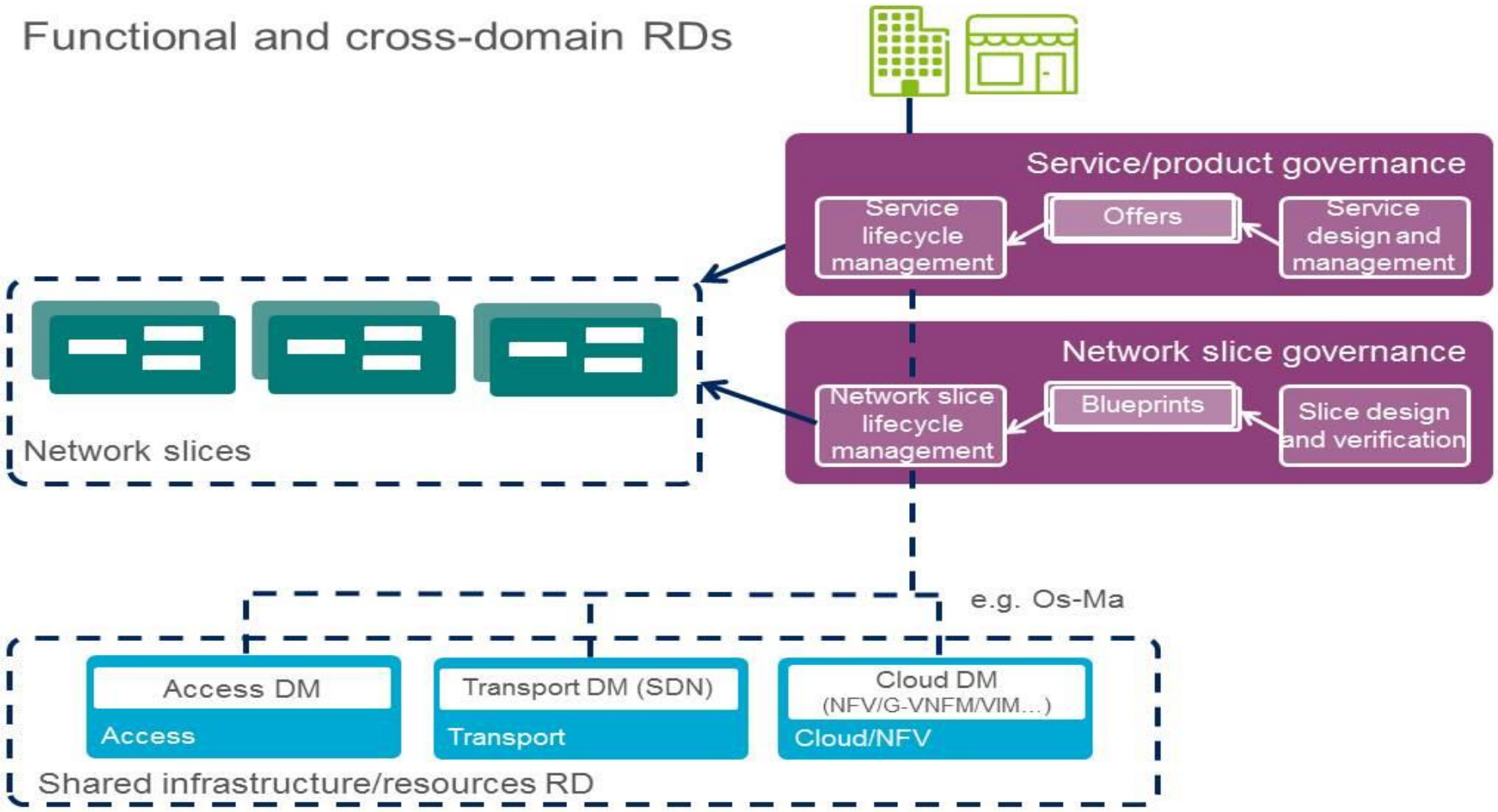
네트워크 진화 요구사항

- **사업 연계성**
  - 타산업 서비스 시스템과 연계성
  - SLA 지원 → reconfiguration
  - 과금, 보안
- **새로운 서비스의 수용성**
  - 유연성
  - 다양성
  - Upgrade
- **독립성**
  - 산업/서비스 간 독립성
- **운영/관리**
  - 타산업 운영 시스템과 연계성
  - 운영/관리의 사업화
- **표준**
  - One network for multiple industries
  - OSS/BSS



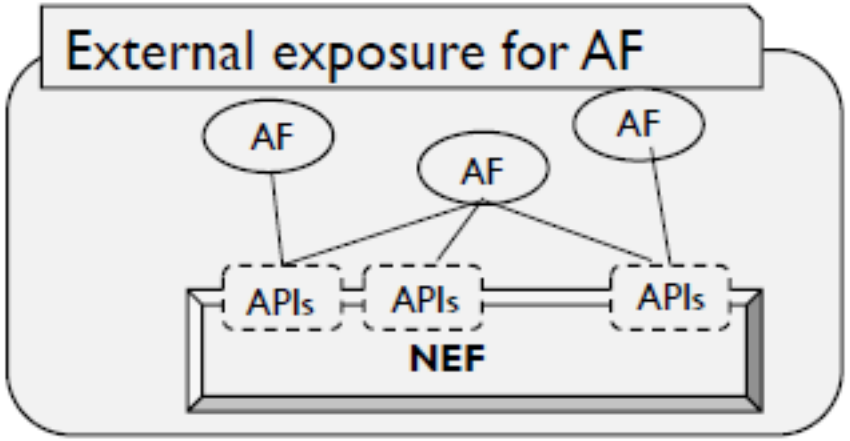
GIGA Korea "서비스 시나리오 개발 사업, 네트워크 파트", 5G 포럼 홈페이지, 2017

계약에 의한 네트워크 재구성



Network exposure function (NEF)

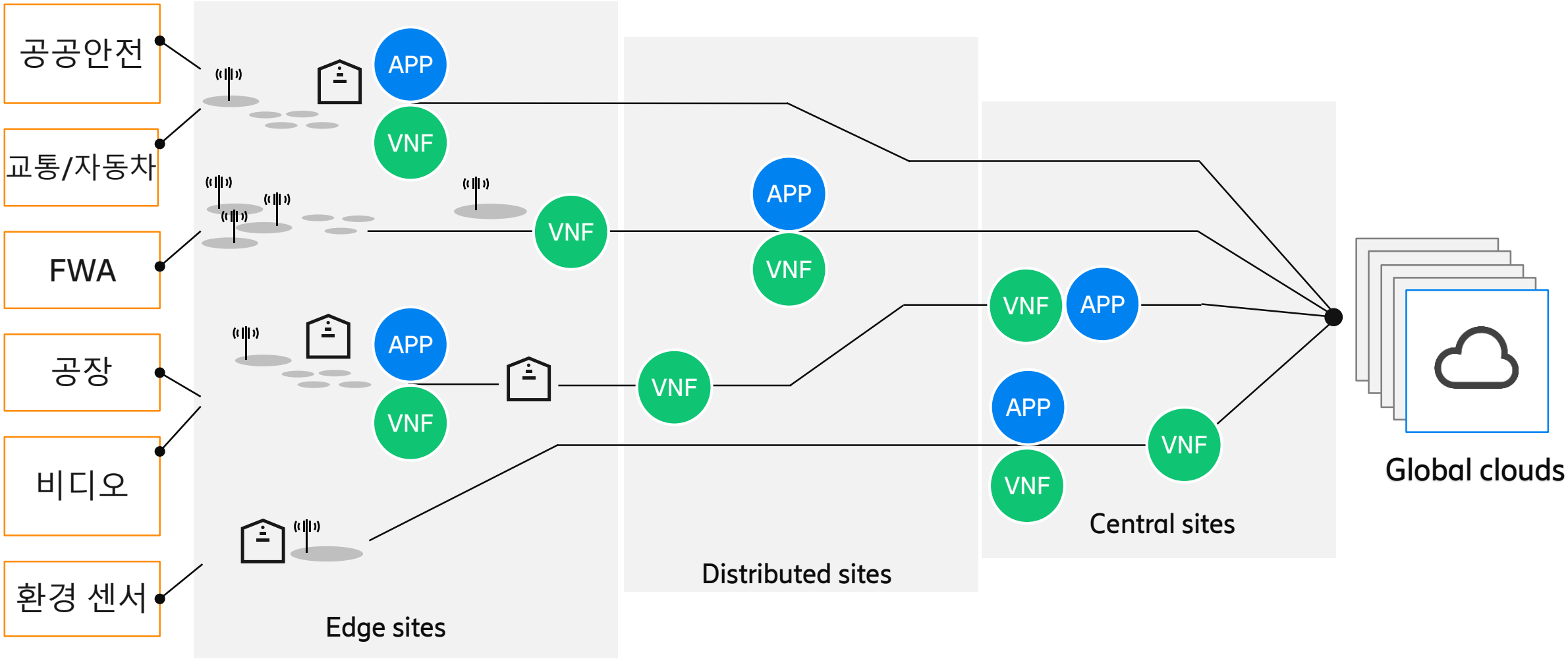
3GPP 네트워크의 서비스와 기능에 대해 안전한 방법으로 사용할 수 있도록 표준화된 인터페이스.
제3자 (타 산업 서비스 제공자 등), 내외부 네트워크, 애플리케이션, Application function, edge computing 등이 사용함.



- AF는 직접 혹은 NRF를 거쳐 트래픽의 라우팅에 영향을 미침 (via SMF to UPF)

- External exposure의 분류
  - 모니터링 기능
  - 프로비져닝 기능
  - 정책/과금 기능

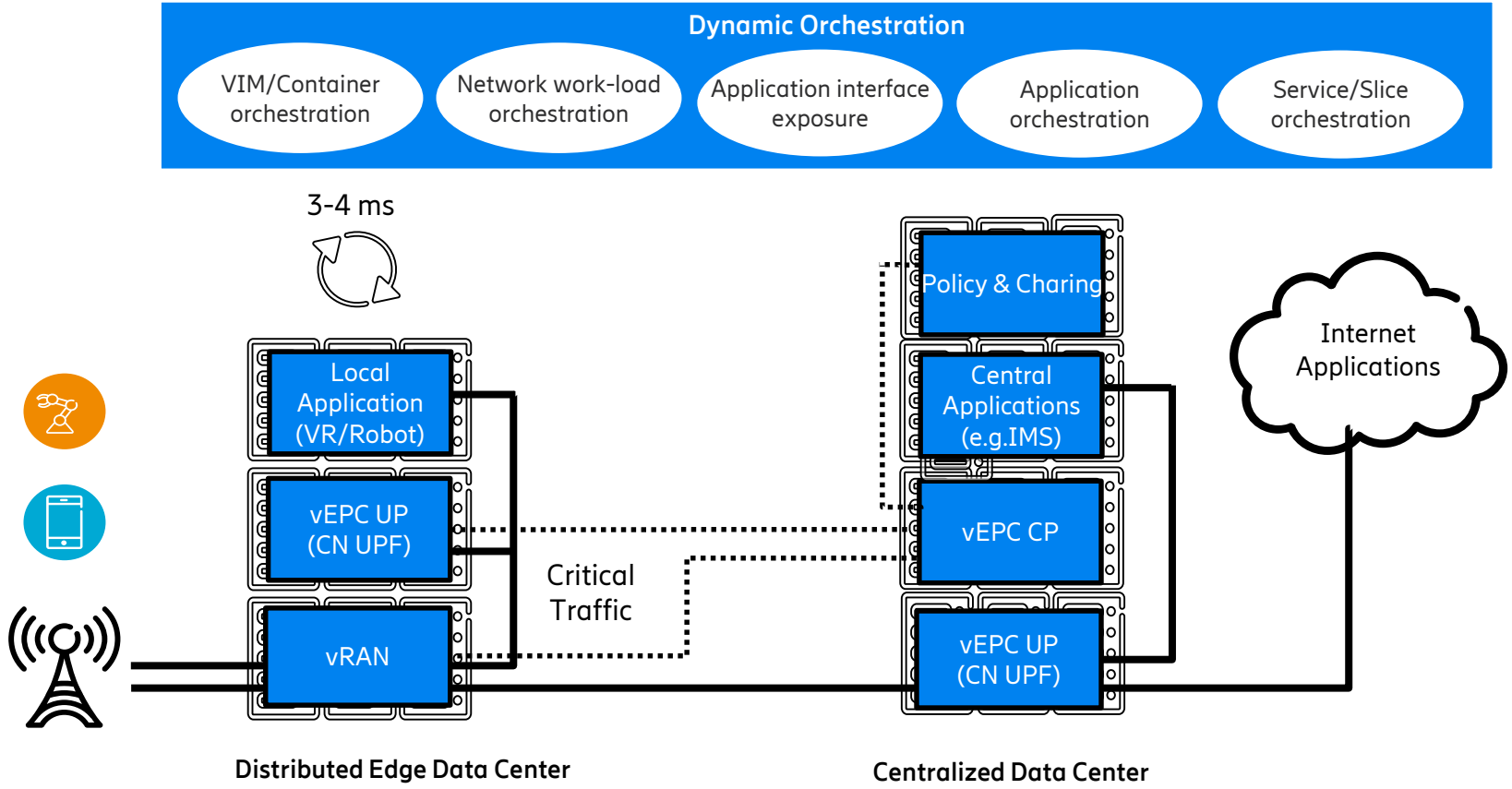
기능 재배치와 분산 클라우드



Any workload | Anywhere in the network | End-2-end orchestrated

Distributed Cloud – enabling technologies

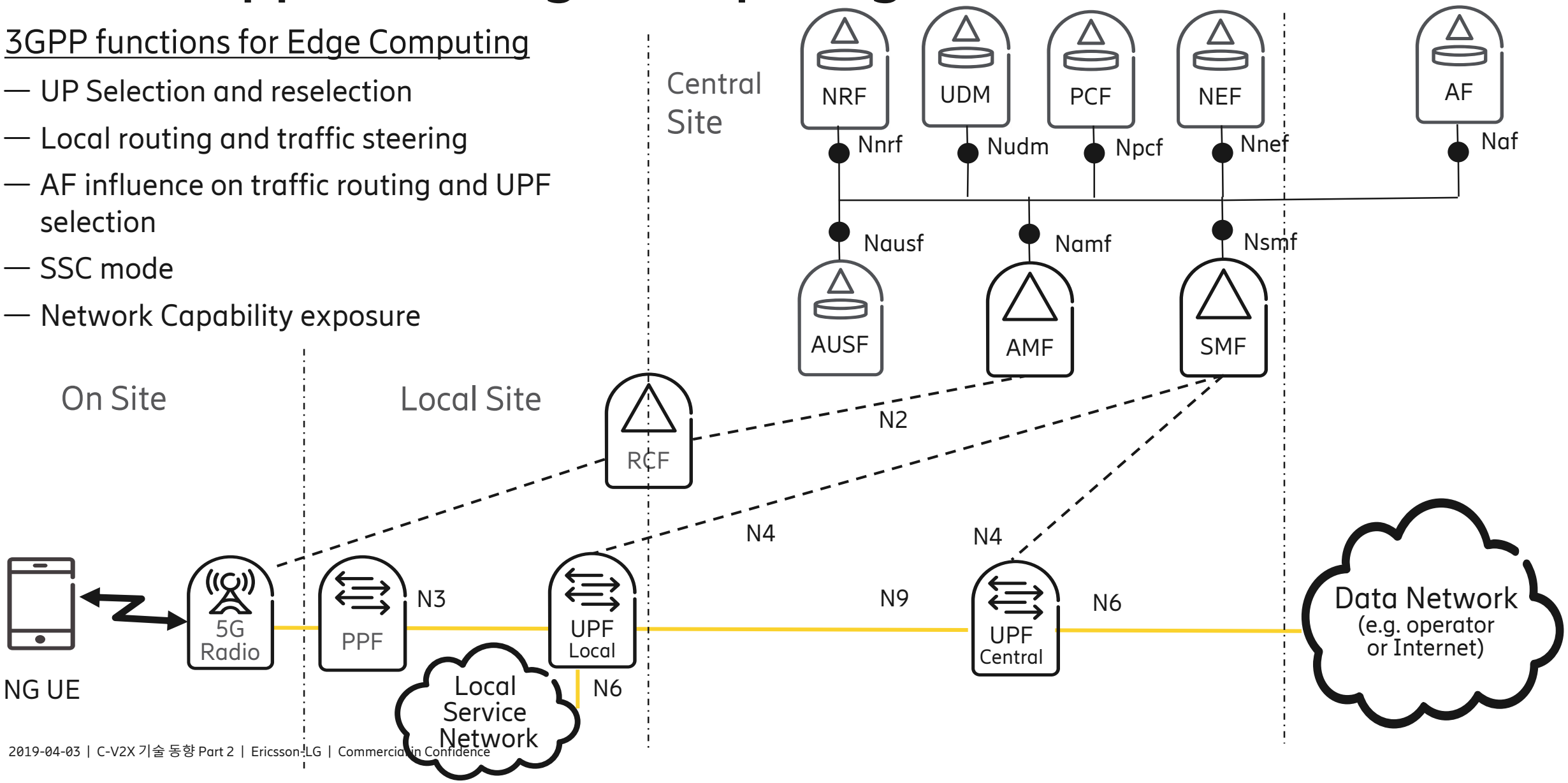
- Dynamic orchestration of workloads and NW slices
- Programmable application interfaces
- Flexible network applications (vRAN, vEPC)
- Scalable execution environments
- Robust server hardware for central offices
- Security for distributed applications



3GPP support for edge computing

3GPP functions for Edge Computing

- UP Selection and reselection
- Local routing and traffic steering
- AF influence on traffic routing and UPF selection
- SSC mode
- Network Capability exposure



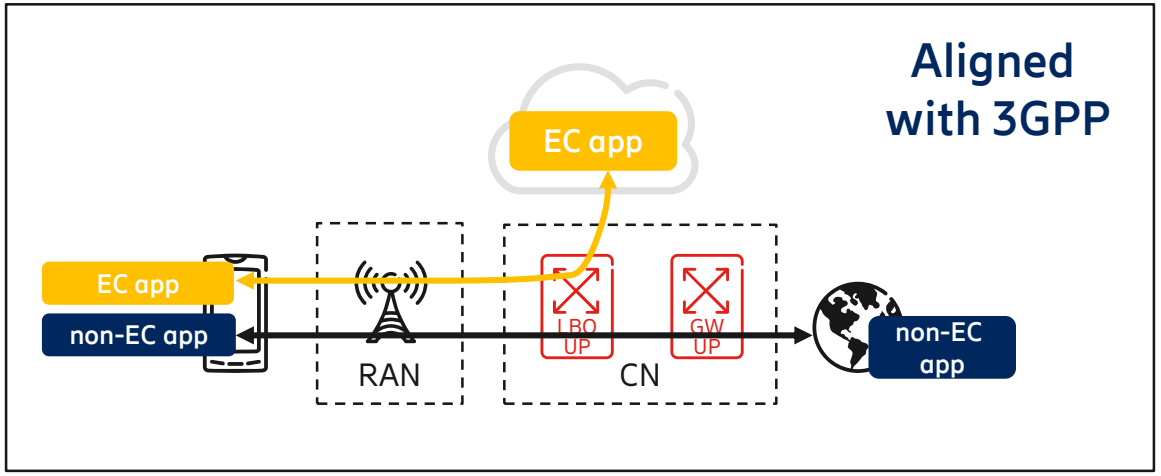
Distributed EDGE vs. MEC

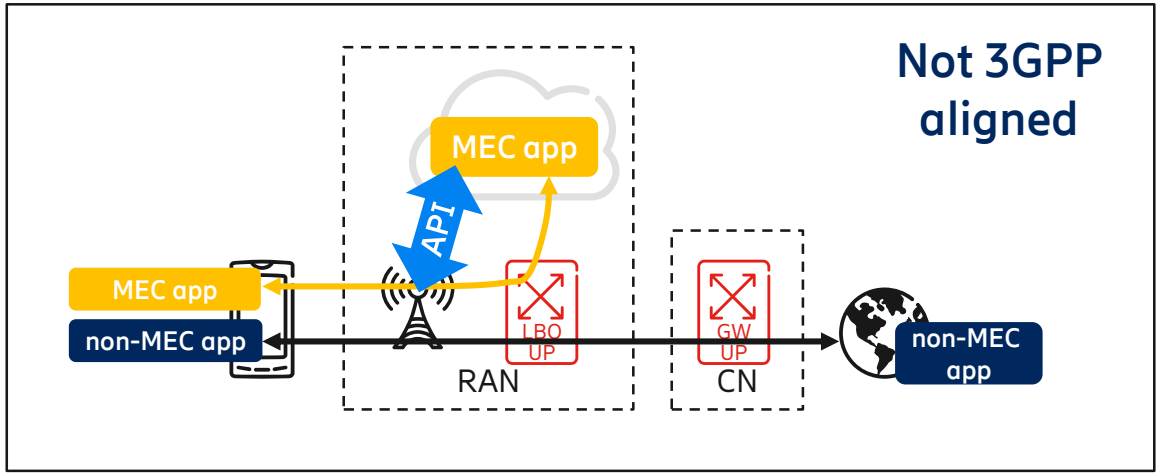
Distributed Edge

- Put computing infrastructures (that host EC applications) close to the network edge
- EC is RAN agnostic
- In mobile networks, traffic must be routed accordingly to and from ECs by means of Local Break Out (LBO) functionality.
- Supported by 3GPP architecture

MEC

- MEC technology is intended to be implemented at the cellular base stations (i.e. RAN)
- MEC opens the radio access network (RAN) to authorized third-parties
- Needs to listen in to info exchanged between RAN and Core (encrypted)
- Requires significant changes to 3GPP architecture





Automotive Edge Computing Consortium

Getting the Infrastructure Ready for Future Automotive BIG DATA

Future Automotive Service

1~10 EB/month Network Traffic

High Definition Map

Intelligent Driving

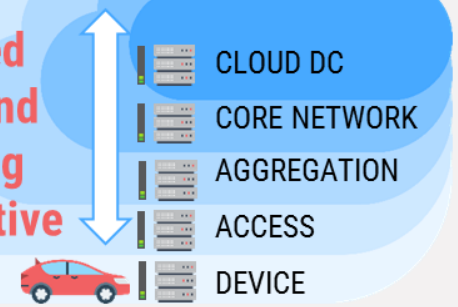
- ✓ Huge amount of data
- ✓ More capacity
- ✓ Improved coverage

100M Connected Cars

Our Work Stream

AECC

Distributed Network and Computing for Automotive



Define use cases and requirements

Focus on Vehicle-to-Cloud

Formulate a roadmap to bridge gaps

Network and Computing for BIG DATA

Collaborate with relevant communities

Global Standardization

Address capacity and efficiency issues

DENSO ERICSSON intel KDDI NTT docomo TOYOTA TOYOTA InfoTechnology Center Co., Ltd.

5G Automotive Alliance

Cross-industry collaboration, telecom & Vehicle Indus.

Automotive Industry

Vehicle Platform, Hardware and Software Solutions

Telecommunications

Connectivity and Networking Systems, Devices and Technologies

End–to–End Solutions for Intelligent Transportation, Mobility Systems and Smart Cities

ERICSSON NOKIA LG QUALCOMM intel DAIMLER BMW AUDI

Drive standards and regulations, end-to-end solutions

5G - a path to new revenues

New consumer services like 8K and fixed wireless

Make enterprises capture the IoT opportunity

Capture the mobile video opportunity with 11 fold consumption increase

Digitalize enterprises with new capabilities

Enable enterprises build truly global, connected solutions

Develop new business models beyond data monetization


감사합니다.