SA WG2 Meeting #158
Goteborg, Sweden, Aug 21 – 25, 2023

The Discussion on Architecture Enhancement for Integrated Sensing and Communication

China Mobile

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The Analysis on potential work tasks in SA2

- Overall 14 WTs were discussed, Current status of Moderated Email Discussion are follows:
  - There is a clear choice on the WTs among the companies
    - The following topics get most support of the companies providing the feedback:
      - **WT#1**: Architecture/Function enhancement to support new sensing service (19 supporters)
      - **WT#2**: Sensing service authorization and control (19 supporters)
      - **WT#3**: Sensing measurement collection/result calculation (18 supporters)
      - **WT#4**: Sensing result exposure (18 supporters)
      - **WT#10**: Discovery and selection of the sensing entities (17 supporters)
      - **WT#5**: Policy/Charging for sensing (14 supporters)
        - » Charging part is led by SA5.
    - Others get fewer than 50% and can be considered as low priority for Rel-19 SA2 study;
  - Majority conveys the willing of having normative work in Rel-19.

ISAC in Rel-19 should focusing on the essential functionalities only, and the consolidated WTs should be based on the WTs received widely support.

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The Analysis on RAN dependency

- Decouple the work of RAN3 and other RAN WGs;
  - **Work of RAN3**:
    - RAN3's WID is aiming at the coordination work with SA2's work on ISAC in Rel-19, scope include:
      - Control plane aspect (e.g., Protocol stack, how to trigger gNB start the sensing service);
      - User plane aspect (e.g., Protocol stack, data format)
  - **Work of other RAN WGs (RAN1):**
    - Independent from SA2 work, scope may include:
      - Channel modeling;
    - **In Rel-19, if the sender and receiver are the same, the way of sending/collecting the sensing signaling can be based on implementation.**

- **Decouple the SA2 work of RAN3 and RAN1. RAN3 provides necessary inputs to SA2.**
- **Length of planned SA2 work for Rel-19 is 15 months, starts from 2023 Q4 and ends at 2024 Q4.**
- **By reasonable controlling the relationship with RAN WGs, ISAC can finish both study and normative work within the Rel-19 time frame.**

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Proposed consolidated WTs in SA2

- **This study aims at studying the 5G end-to-end Integrated Sensing And Communication (ISAC) architecture to enable the sensing services. The proposed work tasks are as follows:**

  - **WT#1 (Architecture):** Study the overall architectural and functional enhancements to support Integrated Sensing and Communication service, e.g., whether new NF is to be introduced to manage the sensing service.

  - **WT#2 (Procedure):** Study and define the operation and procedures for the ISAC service, i.e.:
    - Sensing service authorization and control.
    - Discovery and selection of the sensing entities.
    - QoS handling and potential policy enhancements to support sensing services.
    - Study how to report/transmit Sensing measurement data to 5GC and how to handle it in 5GC.
    - Sensing result exposure.
    - Service Continuity about studying whether and how to enable uninterruptedly providing the sensing service when the tracked target is moving.(If TU is allowed)

  - **WT#3 (Security):** Study the aspects involving security and privacy mechanism for sensing.

    Note: This WT shall be led by SA3.

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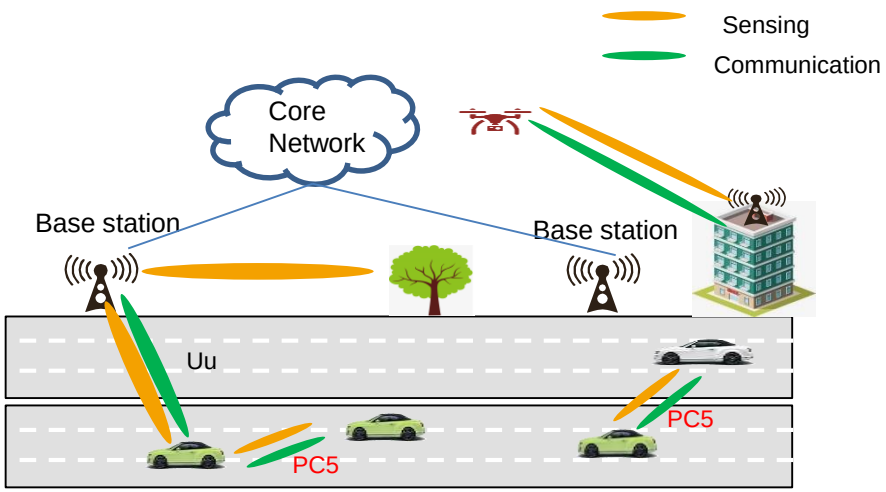
Motivation

- **Integrated Sensing and Communication (ISAC) in 3GPP** means that the sensing capability is innately integrated into the cellular wireless communication system. The 3GPP network system could provide sensing services to address different target verticals/applications, e.g. autonomous/assisted driving, V2X, UAVs, 3D map reconstruction, smart city, smart home, factories, healthcare, maritime sector. Integrated Sensing and Communication(ISAC) is a new capability enabler to extend the 3GPP network market. With the integration of sensing, the network could setup the connection between the physical world and biological world and provide various services for public consumers and industry customers in the future.

- Taking the following advantages of 3GPP network, Integrated Sensing and Communication Capability can meet potential sensing requirements from different industies:
  - Native network-wide sensing
  - Wide coverage
  - Large quantity of sensing devices including NG-RANs/UEs
  - Feasible resource cooperation
  - Interference management



NR as a sensor

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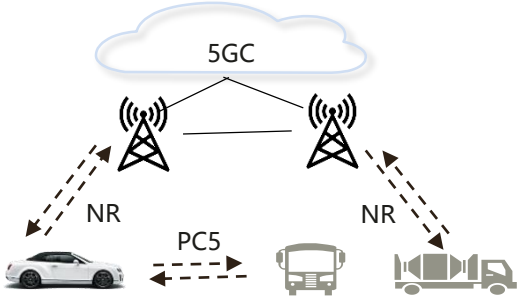
Motivation

	Traditional sensing service			Integration Sensing and Communication
	Sensor	Camera	Radar	
Service Description	• Sensors must be installed or worn; • Short sensing range; • More susceptible to environmental conditions, etc.	• Equipped with a camera; • Poor adaptability to the environment; • Vulnerable to light, shielding, etc.	• Interfere with each other due to lack of coordination; • Small sensing range due to no radar networking; • Accuracy is slightly lower.	Cellular network can construct a native sensing network: • Low cost by reusing the communication infrastructure; • Wide coverage; • High sensing accuracy.
Role of communication nework	Communicaiton network is not involved or only provide channel for sensing data transmission			Sensing service is integrated into 5G System with the existing infrastructure, generating new revenue in sensing market (commercial profits) for operators.

Current sensing application

On-board radar, most local processing

Integrated sensing and communication



NRs involved sensing, local & centralized processing

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6 Possible sensing mode in 3GPP

Network NR as the Receiver

（1）

- Transmitter: Base Station1
- Receiver: Base Station1

（2）

- Transmitter: Base Station1
- Receiver: Base Station2

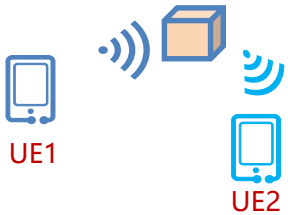
（3）

- Transmitter: UE1
- Receiver: Base Station1

UE as the Reveiver

（4）

- Transmitter: Base Station
- Receiver: UE1



（5）

- Transmitter: UE1
- Receiver: UE2

（6）

- Transmitter: UE1
- Receiver: UE1

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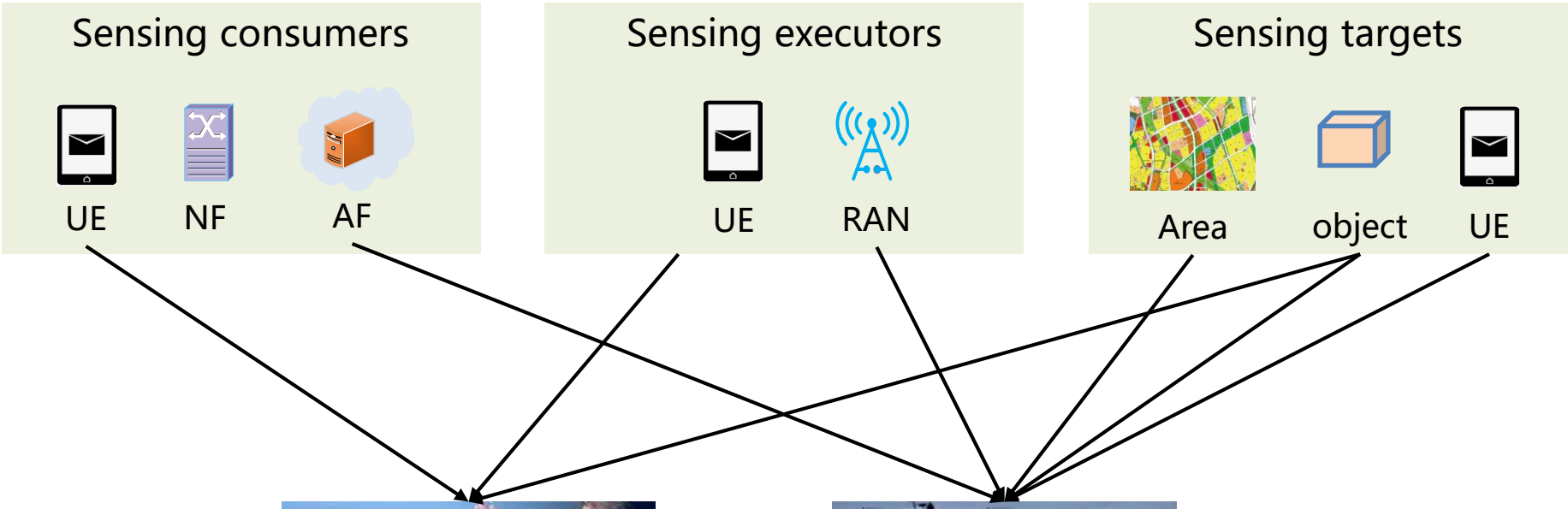
Relationships between sensing scenarios and cellular network

- Based on **sensing consumers, executors, and targets,** the cooperative relationships between sensing scenarios and cellular network could be further studied in 3GPP network.



Example1：Human Computer Interaction

Example 2：UAV

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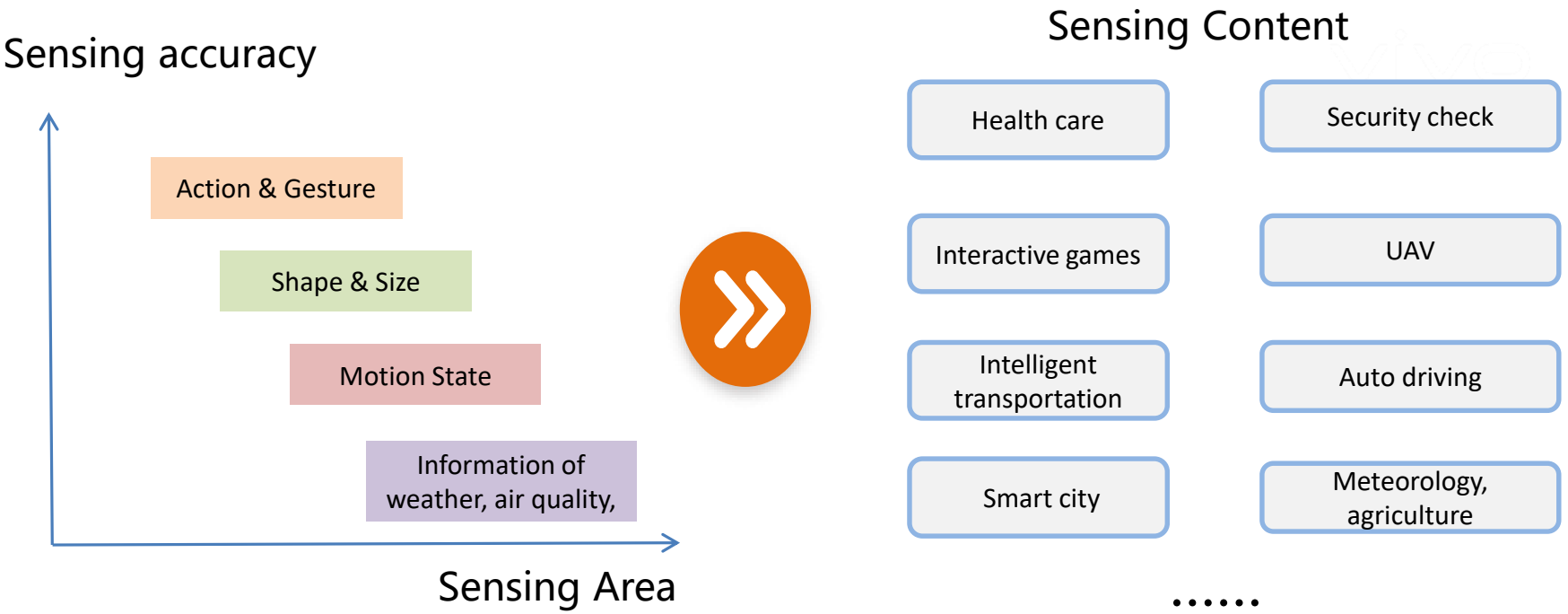
Sensing Contents and Scenarios

- **Integrated Sensing and Communication Network** collects wireless signal intensity, phase, arriving time, and other information, and realizes multi-dimensional and multi-granularity environment and target perception.



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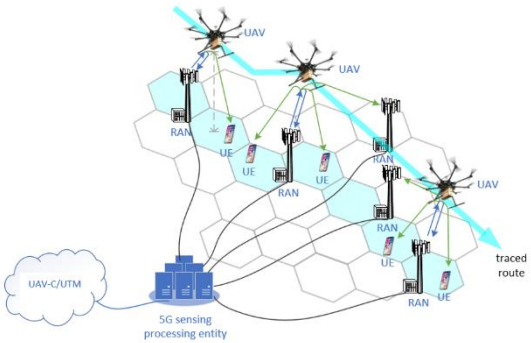
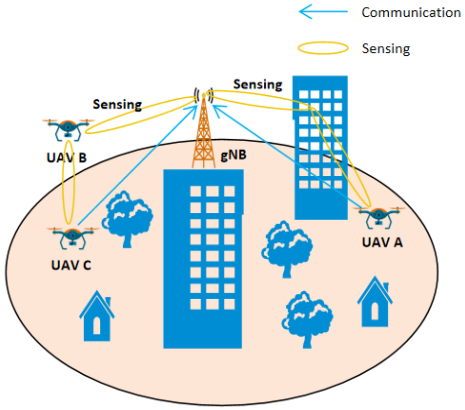
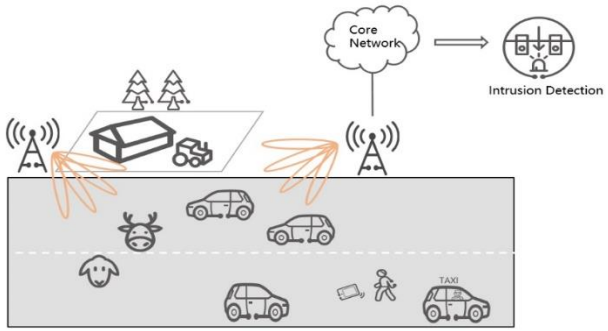
Use Cases example---ISAC in UAV

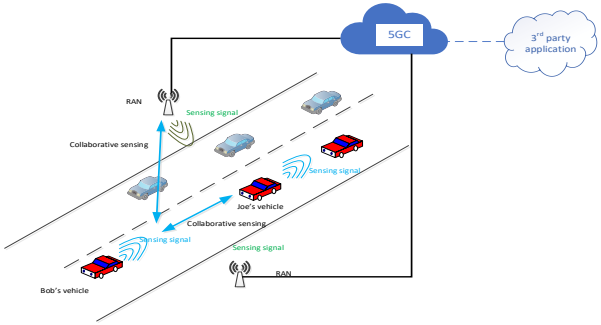


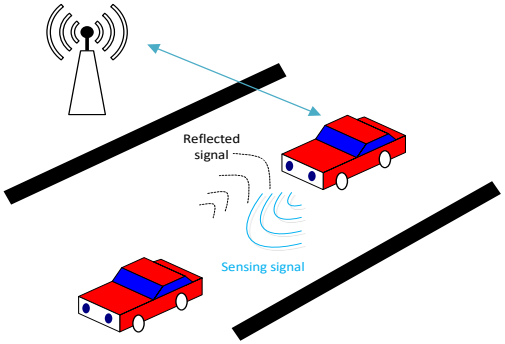


- Sensing for UAV intrusion detection
- UAV flight trajectory tracing by 5G system
- Network assisted collision avoidance for UAVs

Use Cases example---ISAC in V2X







- Pedestrian/animal intrusion detection
- 5G system assisted automotive maneuvering/navigation
- Vehicles Sensing for ADAS

Key requirements:

1. How 5G system be able to provide a sensing service by using base stations or UE

2. How the 5G system shall be able to expose sensing results to a trusted 3rd party application

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ISAC work progress in SA1

Information	
SID	FS_Sensing (R19)
Title	Study on Integrated Sensing and Communication
Rapporteur	DT
# Supporting organizations	30+
SID Tdoc number	S1-220191 (SA1#97e) SP-220717
Finish time	Jun-2023
Progress	**80%**
TR number	22.837
Scenarios	**32 use cases**

Scope

- Focus on NR sensing
- Using information already available in EPC and E-UTRA, will not lead to impacts on EPC and E-UTRA

Scenarios

TR refers to 32 scenarios, covering 6 aspects: Smart transportation, UAV, Smart living, Smart city, Smart factory, data privacy/security

Sensing options (modes)

- UE Tx + UE Rx
- gNB Tx + gNB Rx
- UE Tx + gNB Rx
- gNB Tx + UE Rx
- UE Tx + other UE(s) Rx
- gNB Tx + other gNB(s) Rx

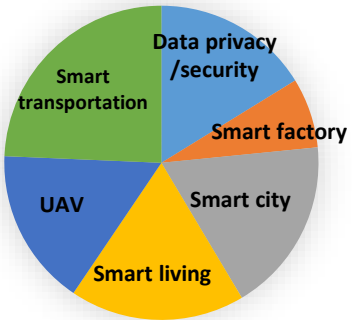
About KPI

Specified the KPIs for the general cases, including Sensing Accuracy, and Sensing Resolution, Max sensing service latency, Refreshing rate, Missed detection probability and False alarm probability.

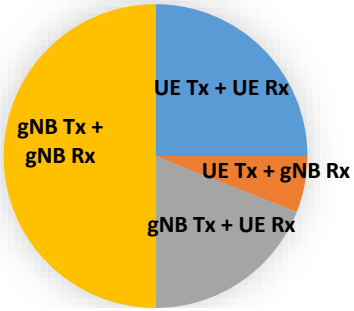
Sensing data

Defined 3GPP sensing data, None 3GPP sensing data and Sensing result.

Scenarios



Sensing options (modes)



The functional requirements may focus on the following aspects:

- **General requirement for sensing operation/service**
- **Discovery of sensing device**
- **Sensing operation control**
- **Sensing data collection/delivery**
- **Sensing result derivation**
- **Sensing result exposure**
- **Security and charging**

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Network Architecture enhancement is required to enable the sensing business

Sensing Brings New Challenges/Opportunities to 5GS

- **Sensing is different from traditional 5G service**

① UE communication → Area sensing management

② UE-specific data → base station-specific sensing data

③ Pipe-based transmission → sensing content calculation

④ UE security protection → object privacy assurance

⑤ Heavy architecture → flexible and easy deployment of sensing capability

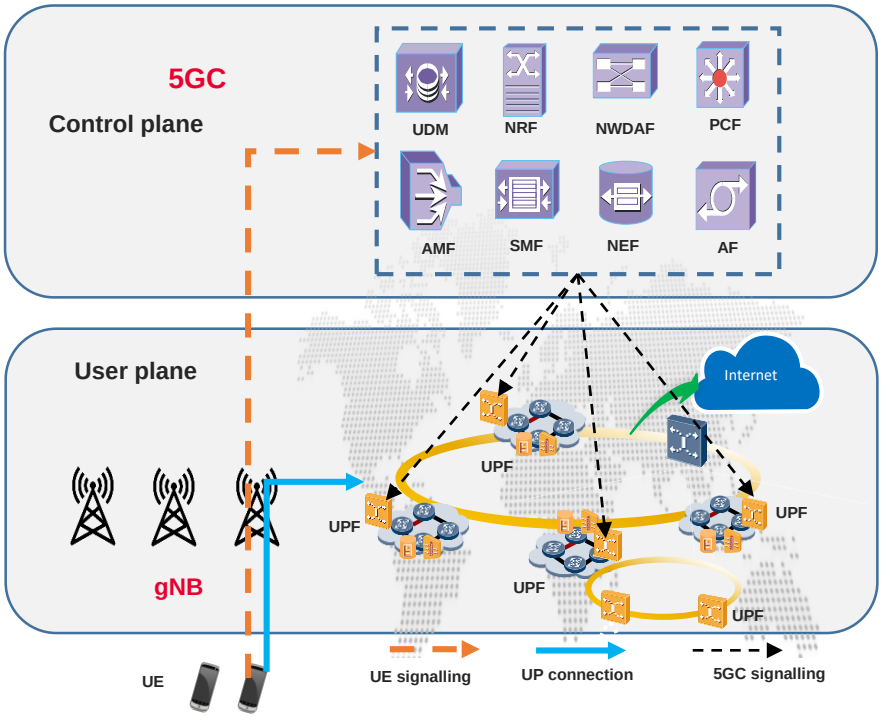
- **5GC enable sensing services**

① 5GC exposes the sensing result as a network service/SaaS

② 5GC performs sensing QoS/type/area control

③ 5GC performs sensing authorization, security and privacy assurance.

④ 5GC handles the sensing data and control both the RAN and UE-related sensing issues.



Network architecture needs new service logic for sensing capability.

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Thanks!

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