

Network vision and activities towards 5G

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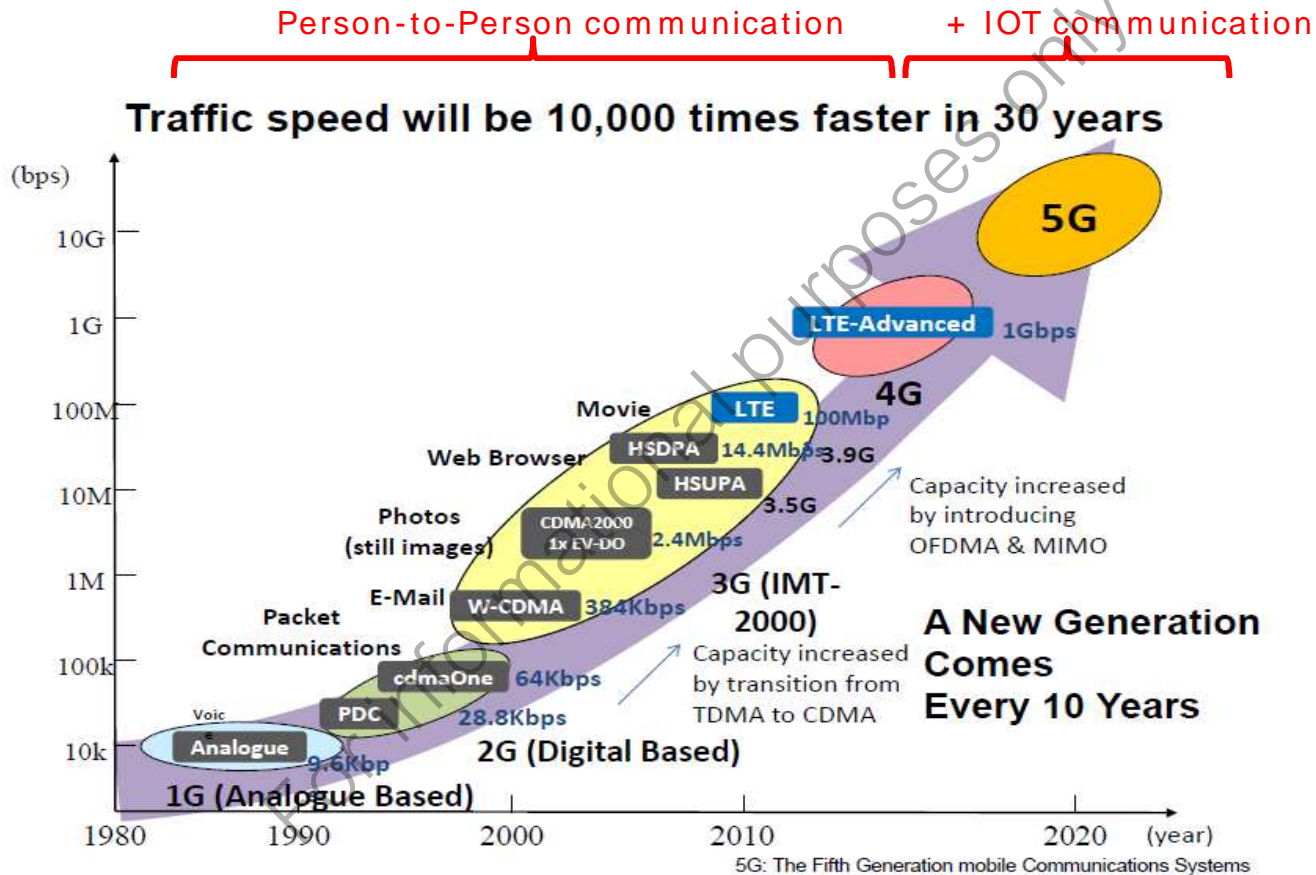
Orchestrating a brighter world

NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow.

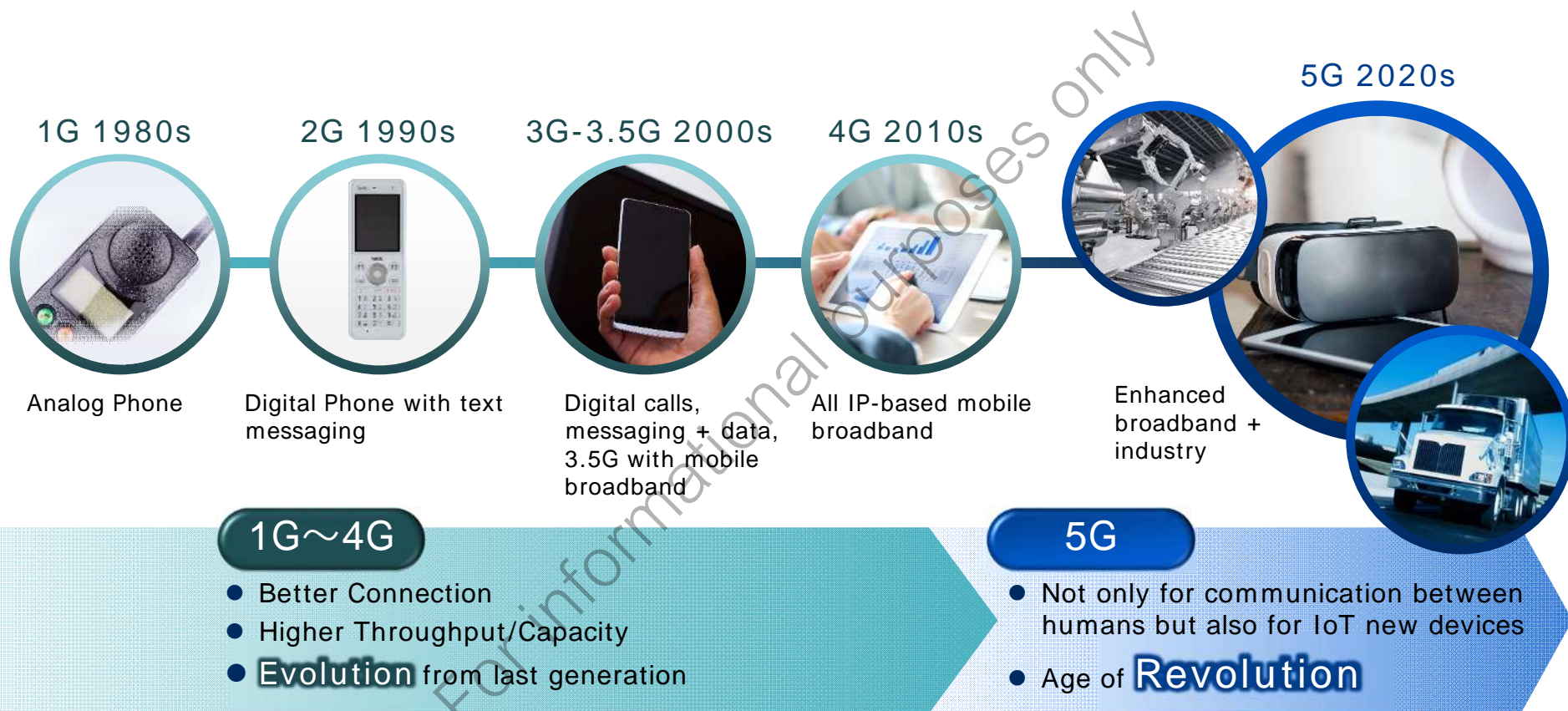
We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs.

Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.

Mobile Network Evolution Trend

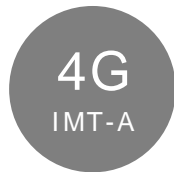


5G, the Era of Revolution in Mobile History



Source:IHS

5G in Figures



10Mbps

1Gbps

350km / h

10ms

$10^5 / \text{km}^2$

$0.1 \text{ Mbps} / \text{m}^2$

High-res video streaming
(HD, 4K, 8K...)

High-capacity file download
(DVD BD class)

High-speed transportation
(e.g. maglev/linear-motor vehicles)

Even lower latency
(AR, fighting games, remote-controlled medical treatment)

Popularization of IoT
(17% annual growth rate)

Increase in traffic
(40%+ annual growth rate)



100Mbps~1Gbps

20Gbps

500km / h

1ms

$10^6 / \text{km}^2$

$10 \text{ Mbps} / \text{m}^2$



High-res video streaming



Online content 10 times the quality



SCMaglev (500km/h)



Low delay (fighting games, AR)

Three Transformations Achieved by “5G. A Future Beyond Imagination.”

Social, Network and Operation Transformation

5G. A Future Beyond Imagination.



Role of ICT in 5G Era

Next Generation ICT Infrastructure to support Diversified Services

Sustainable
Earth



Safer Cities &
Public Services



Lifeline
Infrastructure



Industry
Eco-System



Work Style



Quality of Life



Social
Transformation



Service Cooperation

Ecosystem

End to End Orchestration

Operation
Transformation

Network
Big Data



Centralized
Control

Network
Transformation



Creating New Social Value with 5G



Smart house
Voice agent



Healthcare
Remote diagnosis



Entertainment
4K/8K video



Agriculture, forestry & fisheries
Automated farm management



Retail
Shopping mall
hospitality SL



Sports
E-stadium



Work sites
Remote-controlled
construction site work



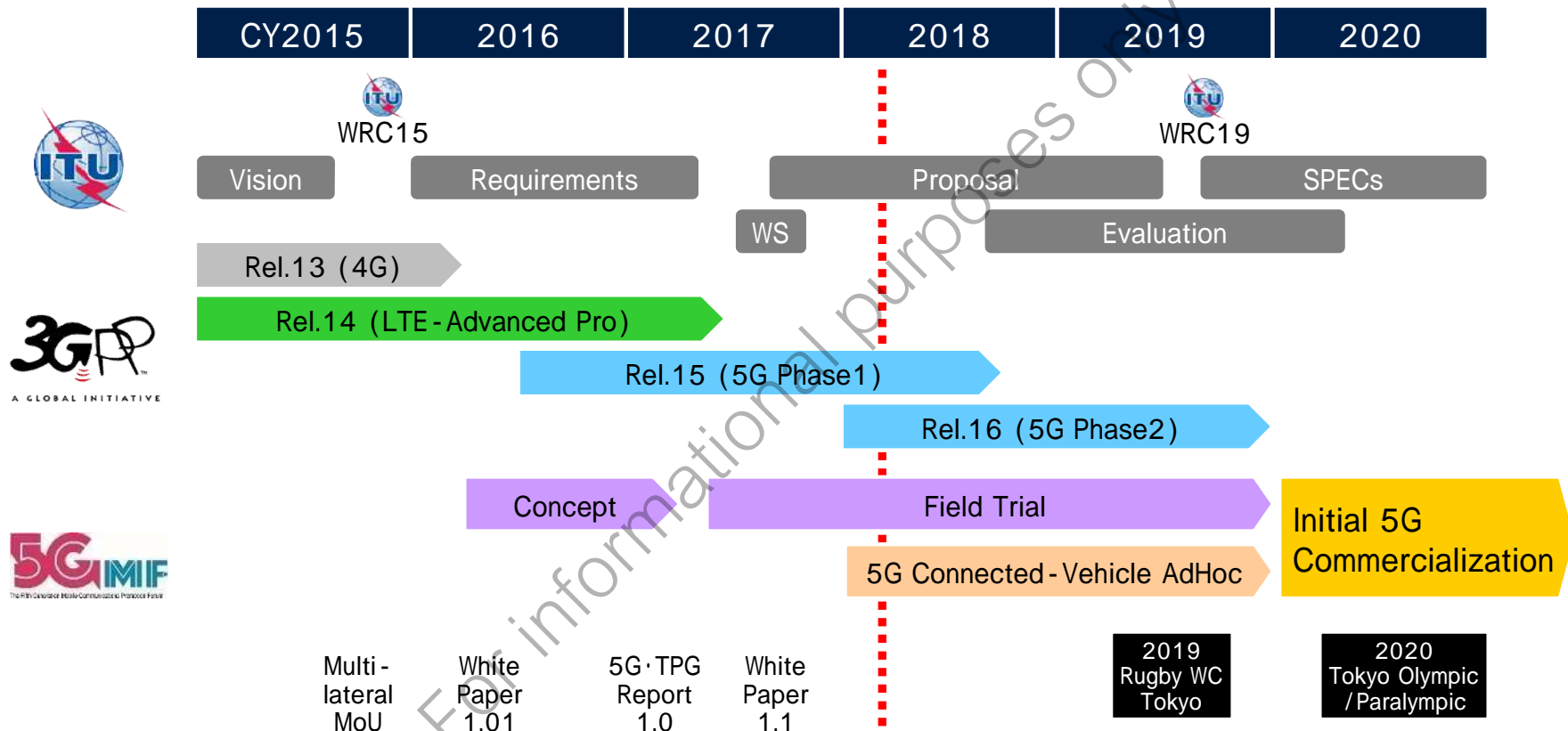
Smart city
Advanced security



Activities towards 5G

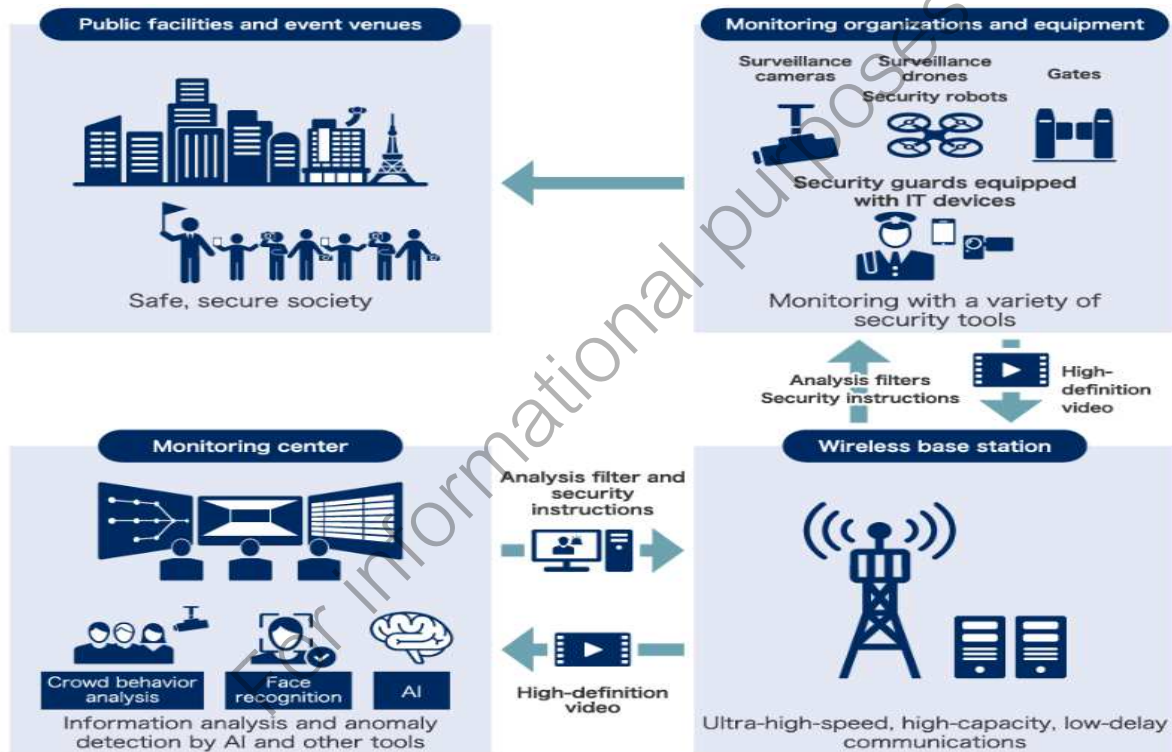
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5G Milestone (including activities in Japan)



(Demo Testing) Advanced Security Services

With a growing need for the detection of warning signs and the advance prevention of crime and various other threats, it is necessary to provide advanced security services that enable such measures as the detection of abnormalities using image analysis.



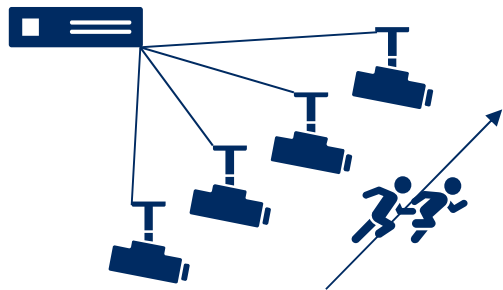
Necessity of 5G (Low Latency, High Capacity)

Auto tracking of a suspicious person

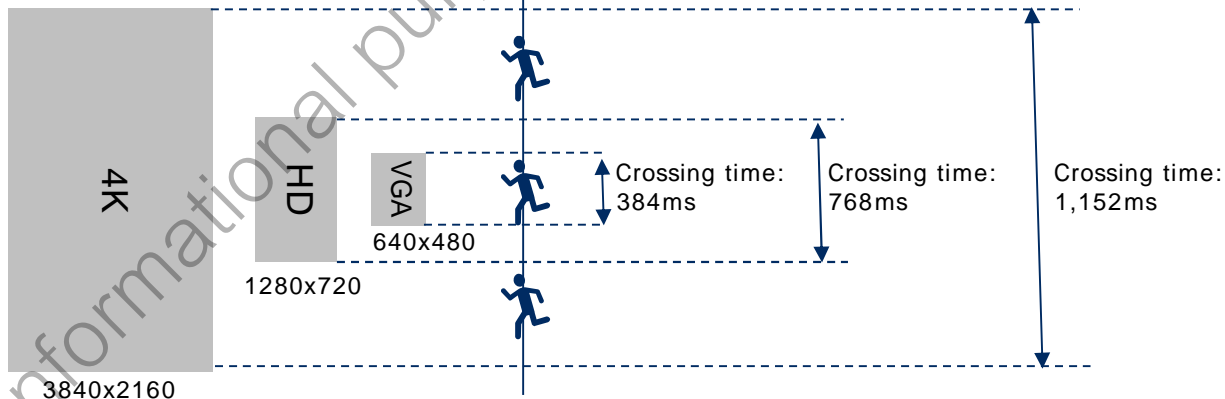
- Face recognition of a suspicious person which is crossing the front of a security camera is necessary in order to auto tracking.
- Very short time is allowed in order to conduct face recognition of suspicious person.

Auto tracking

Face recognition server



Time for crossing the front of a camera (running person: 5m/s)

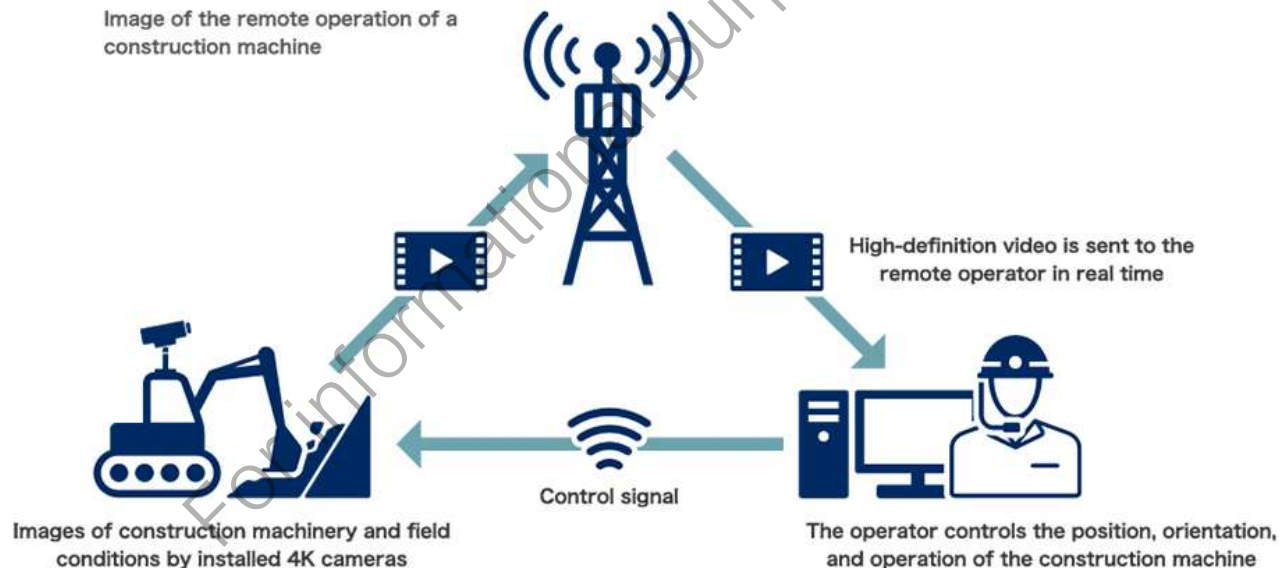


- At least 50 pixels are needed for face recognition.

- Video encoding/decoding, video analysis and data transmission should be done within the above time. Low latency transmission link is necessary. (5G)
- 4K video is better in terms of available time for face recognition. High capacity transmission link is necessary. (5G)

(Demo Testing) Remote-Controlled Construction

- **Current issues with remote-controlled construction:** There are currently constraints in terms of increasing the definition of video streaming due to restrictions on communication speeds, as well as frequent transmission faults due to interference problems.
- **Solution to these issues:** By achieving transmission of high-definition video, which is difficult with existing mobile communications, through utilization of the distinctive features of 5G—high-capacity and low latency, NEC will seek to improve the workability of remote-controlled operation of construction machinery.



Remote operation using 5G network (Sample)

Difficult to operate due to
NW latency and interference

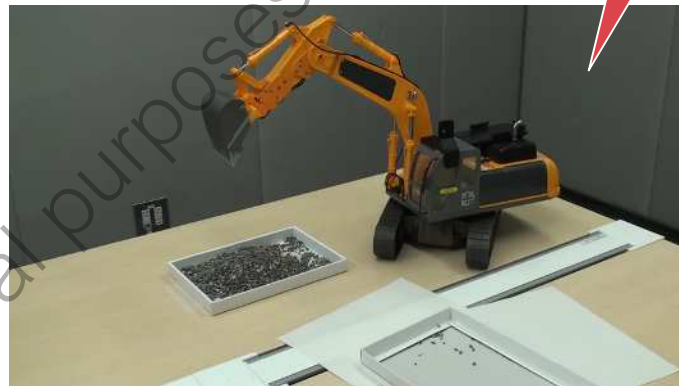


Existing NW

(low throughput with latency)

- Overshoots due to latency/delay
- Halts due to interference/NW instability

Smooth operation with 5G's
low latency & high capacity



5G NW

(High throughput with low latency)

- No overshoot
- Stable operation

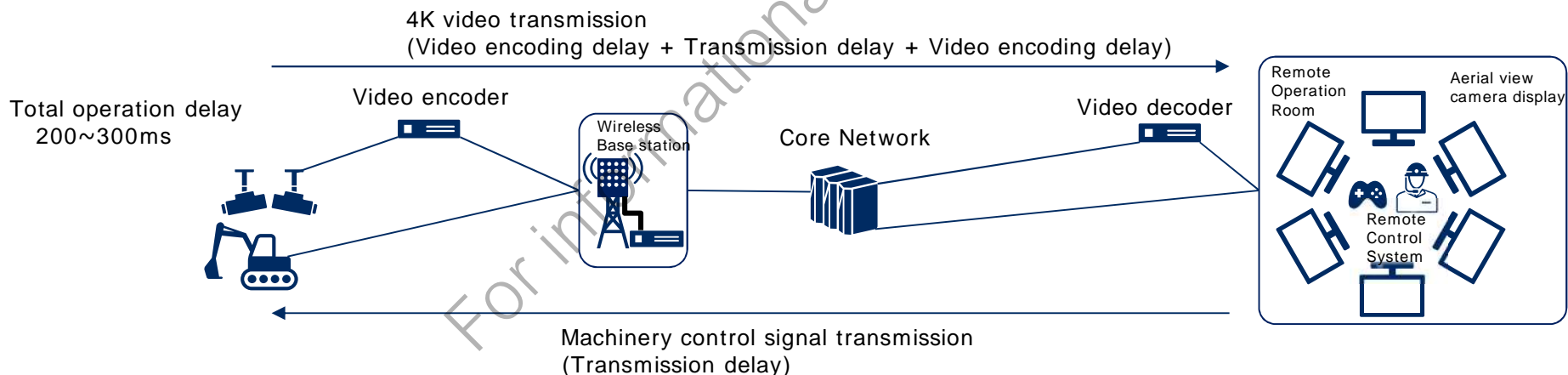
Note: This is a sample showing the influence of NW latency in remote operation. The video on the right demonstrates low latency supposedly to be realized in 5G NW.

Necessity of 5G (Low Latency, High Capacity)

Real-time remote machinery operational/control

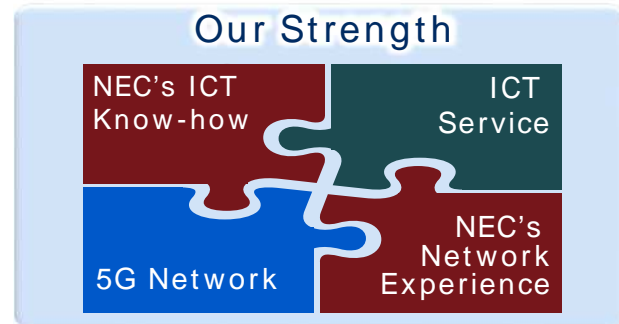
- If the operation delay is large, problems such as feeling of incompatibility arise in operation.
- So it is necessary to provide low delay (several hundred millimeter second at maximum) operation for smooth operation.
- Operation delay includes the transmission delay and the video encoding/decoding delay.

ICT technologies such as ultra low delay codec are necessary in addition to 5G radio and MEC.

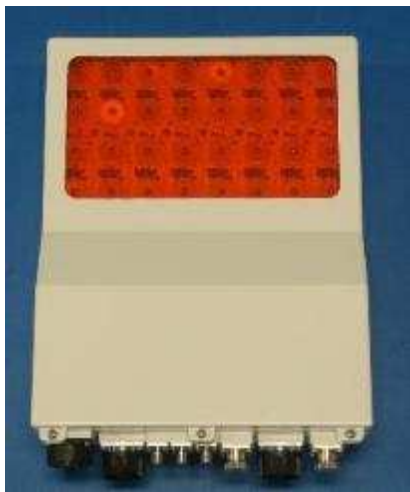


NEC's Strength: Expertise in both ICT and NW solution

- NEC's rich ICT solution, Know-how and Experience help to realize Social Transformation.
- Creating optimized network with NEC 5G solution for each industry customer services.



Massive MIMO AAS for Sub-6GHz



NEC's Massive MIMO Specialty:

- Highest level of frequency efficiency
- Reduction of equipment size & RF loss

	Specification
Frequency, Bandwidth	4.6GHz Band, 100MHz
Duplexing	TDD
#Antenna elements	64 elements(=8x4x2polarities)
Beam control	Full-digital
EIRP	45.4dBm/single-beam
DU/CU interface	10GbE
Supply, Consumption	DC-48V
Dimension, Weight	287x350x52~83mm, 7kg

ACKNOWLEDGEMENT
This presentation includes a part of results of "The research and development project for realization of the fifth-generation mobile communications system"
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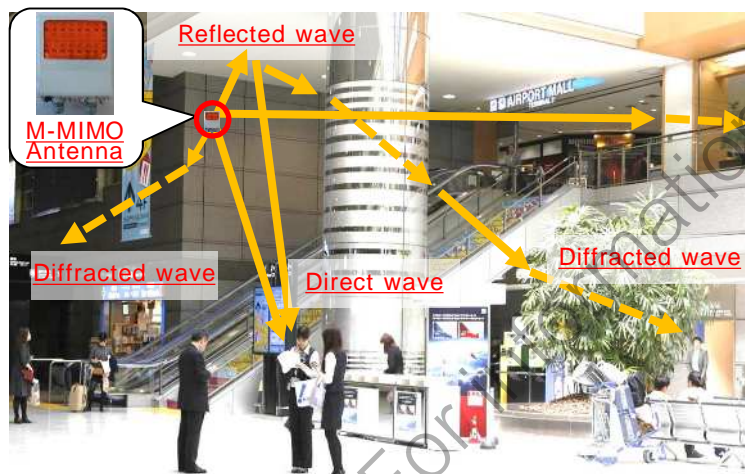
Massive MIMO AAS for Sub-6GHz: Use case

NEC's Differentiator #1

Flexible Beam pattern configuration
& Multi-path management



Optimize coverage & capacity



NEC's Differentiator #2

Small size &
Light weight



Beautification & easy installation



Massive MIMO AAS for mmWave



	Specification
Frequency range	27.5~29.2GHz
Bandwidth	Up to 300MHz
Duplexing	TDD
# of Antenna elements	360 elements
Beam control	Full-digital in AZ, Consequent-squared fixed in EL.
EIRP	59dBm
Supply, Consumption	DC-48V、 450W AC100V、 710W
Dimension	AAS: 199(W) x 308(H) x 225(D) mm

NEC's Massive MIMO Specialty:

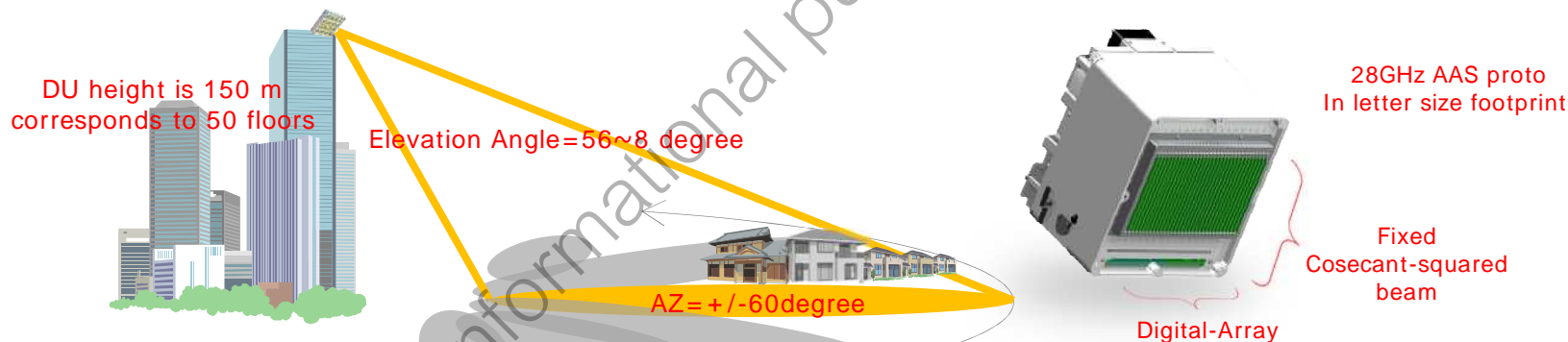
- Field proven reliable mmWave circuit and device technologies. experienced on the point to point radio communication products "iPASOLINK^[1]" operating in more than 150 countries
- Reduction of Massive MIMO AAS size

[1] <http://www.nec.com/en/global/prod/nw/pasolink/>

Massive MIMO AAS for mmWave: Use case

Benefits/Features

- The beam forming is efficient to maintain the mm-Wave propagation channel.
- Using already existing Macro-site or the long-range cell controlling save/minimize the additional investment for the fiber and sites.



Virtual Cells through Digital Beamforming

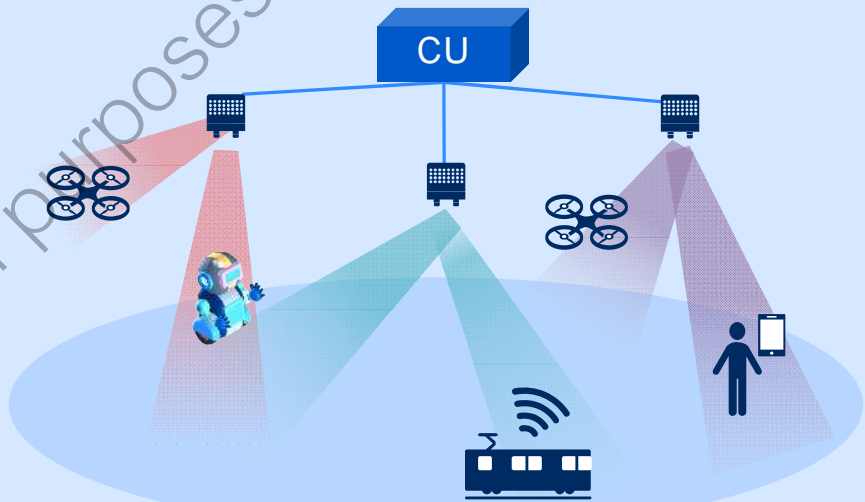
Flexible Coverage, Flexible Capacity

Traditional Deployment



- Fixed coverage
- Fixed capacity

Cell Virtualization

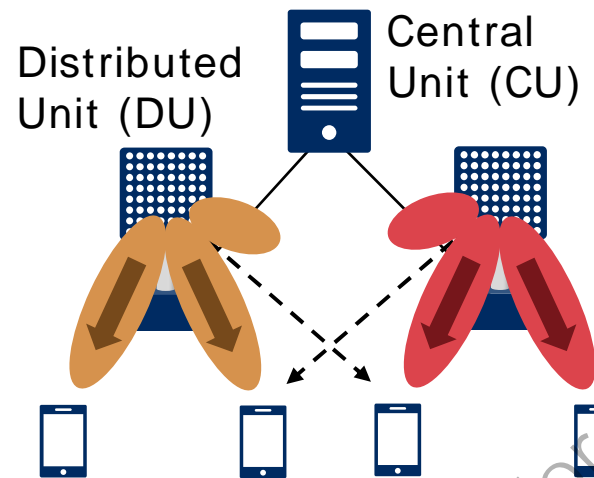


- Flexible coverage
- Flexible capacity

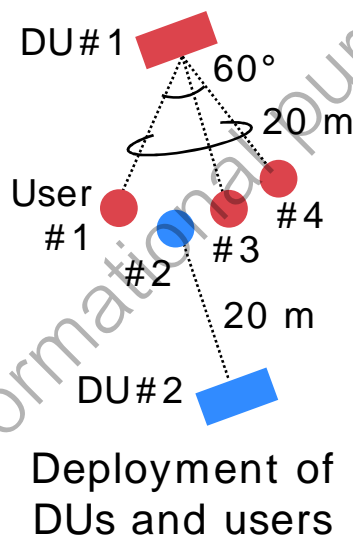
High quality communication can be achieved under virtual cell

NEC's Inter-Site Coordination Technology

Coordinated beamforming (CB) improves throughput performance, especially for users suffering from high inter-site interference, by suppressing the interference.



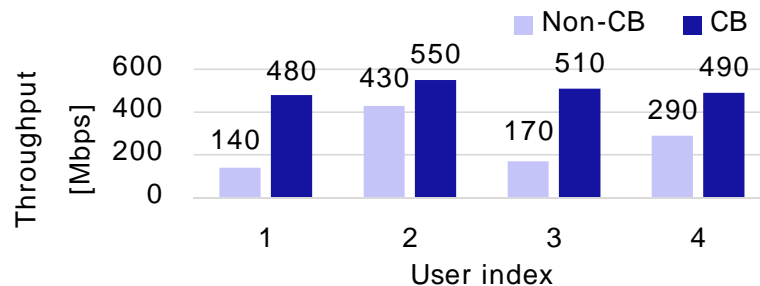
Coordinated beamforming



Performance evaluation by simulation

Simulation conditions

Carrier frequency	4.6 GHz
System bandwidth	80 MHz
No. of DU antennas (row, col., pol.)	128 (8,8,2)



Conclusion

- 5G is NOT evolution from 4G. It's age of **Revolution**.
- **IT and Communication should be tightly combined** to realize social transformation.
- **Collaboration with various industry players** is essential to create social values with 5G.

5G. A Future Beyond Imagination.

 **Orchestrating a brighter world**

NEC

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