Feasibility study of *liquid immersion* technology for cooling *network equipment*

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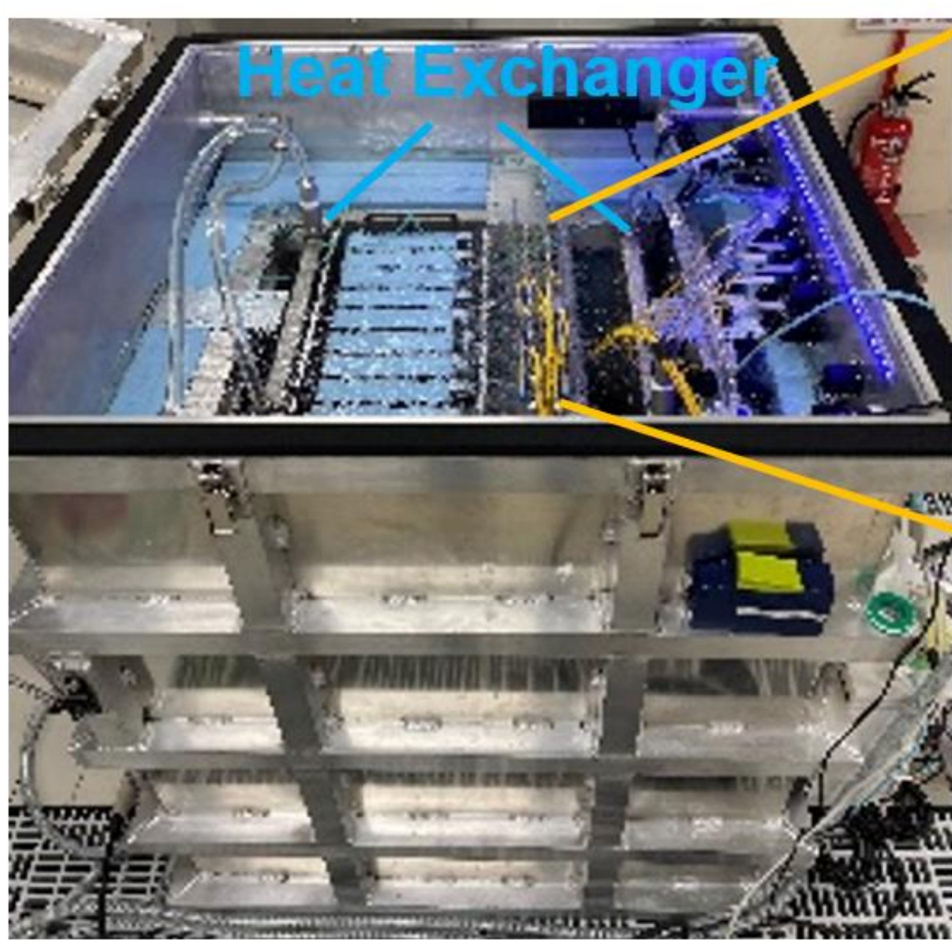
Summary

1. Feasibility of a liquid immersion cooling technology for the ***network equipment***, including ***high-end core switch*** and ***core-router*** with high heat-density as a hot spot in a communication machine room and also a data center, was demonstrated.
2. Combination of the liquid immersion cooling technology especially with the ***bubble assist*** and the ***dielectric material coating on optical communication module*** such as polyimide enabled both sufficient cooling efficiency and communication stability at ***40Gb/s***.
3. PUE of around ***1.02*** was demonstrated for the high-power communication equipment which is the only source of heat generation in communication machine room, achieving the same effectiveness as for the servers.

Method



Top view of Lea-Spine switch with bubble assisted natural convection

Fig.1. Experimental apparatus for liquid immersion cooling for network equipment with bubble assisted natural convection.

TABLE I Typical characteristics of evaluated optical module for leaf-spine switch.

Optical Module	Communication Speed (Gb/s)	Spec	Coating
MM(BiDi) QSPF	40	Wavelength: 832nm-918nm Transmission Optical Power: -2~5dBm Receiving Sensitivity: <-6dBm Communication Speed: 40 Gb/s	Required
SM(LR) QSFP	40	Wavelength: 1310nm Transmission Optical Power: -7~2.3dBm Receiving Sensitivity: <-13.7dBm Communication Speed: 40 Gb/s	Required
MM(SR) SFP	10	Wavelength: 850nm Transmission Optical Power: -3~9.5dBm Receiving Sensitivity: <-17dBm Communication Speed: 10 Gb/s	Not Required

Result 1

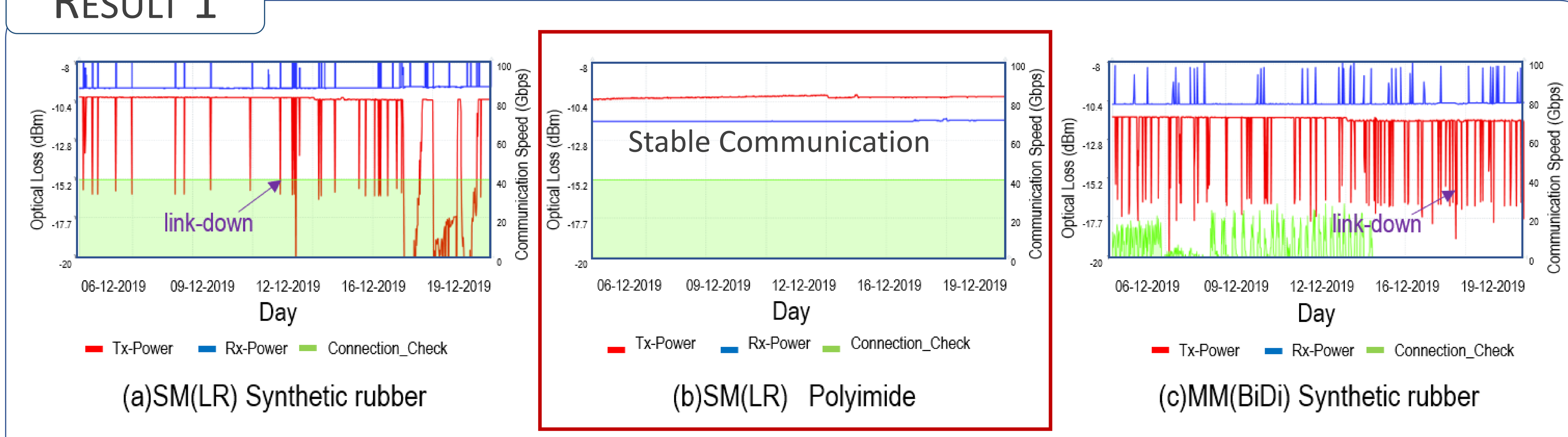


Fig.2 Comparison of optical communication stability in Fluorinert refrigerant for 3 optical modules with different coating material.

Result 2

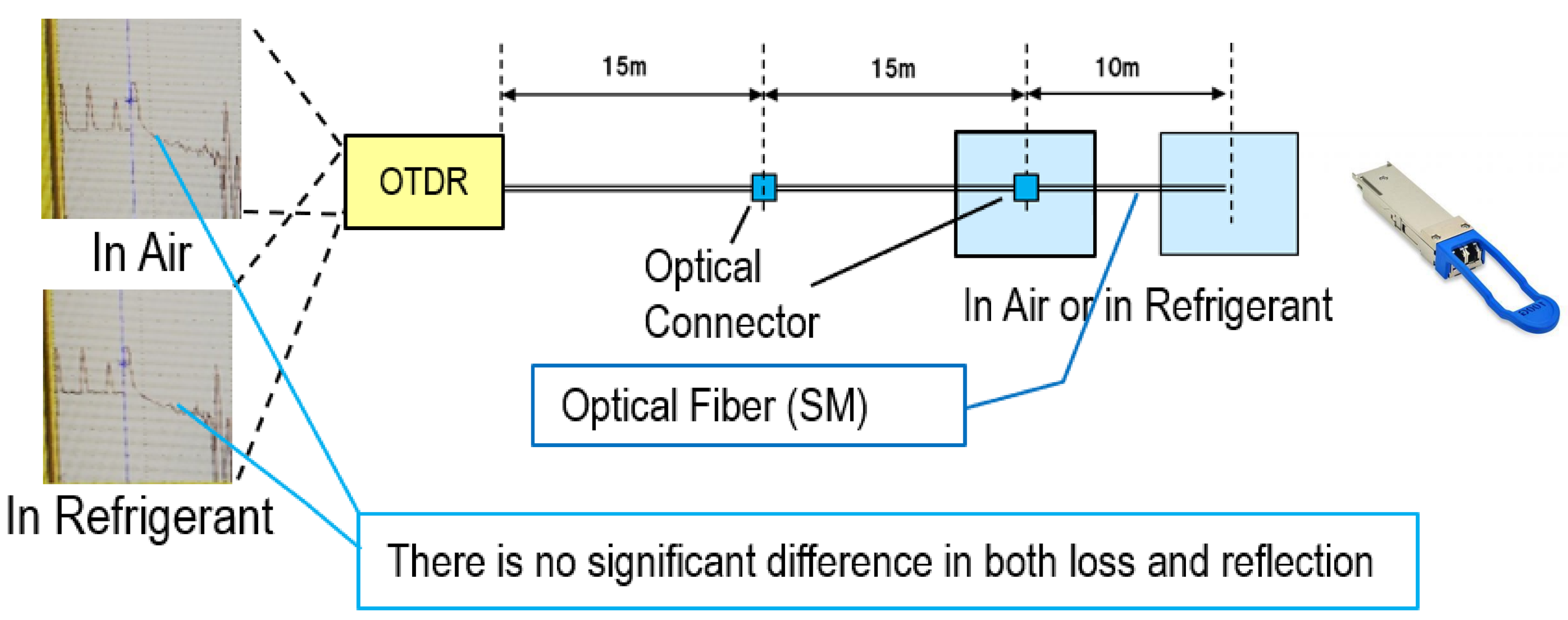


Fig.3 Evaluation system (OTDR) for optical transmission / reception characteristics of optical module.

Result 3

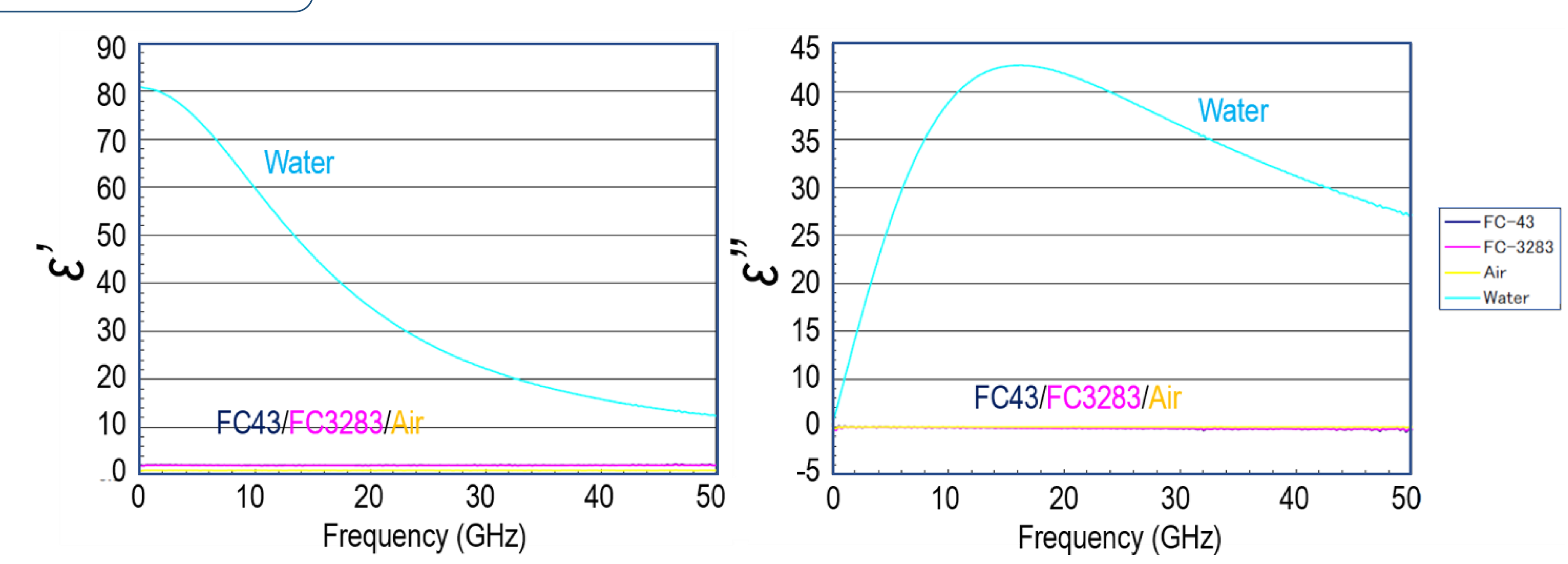


Fig.4 Change in dielectric characteristics with frequency for 3 refrigerants, including Fluorinert FC43 and FC3283, measured at 23 degrees C by impedance analyzer. The value was calibrated by pure ion-exchange water and air value.

Result 4

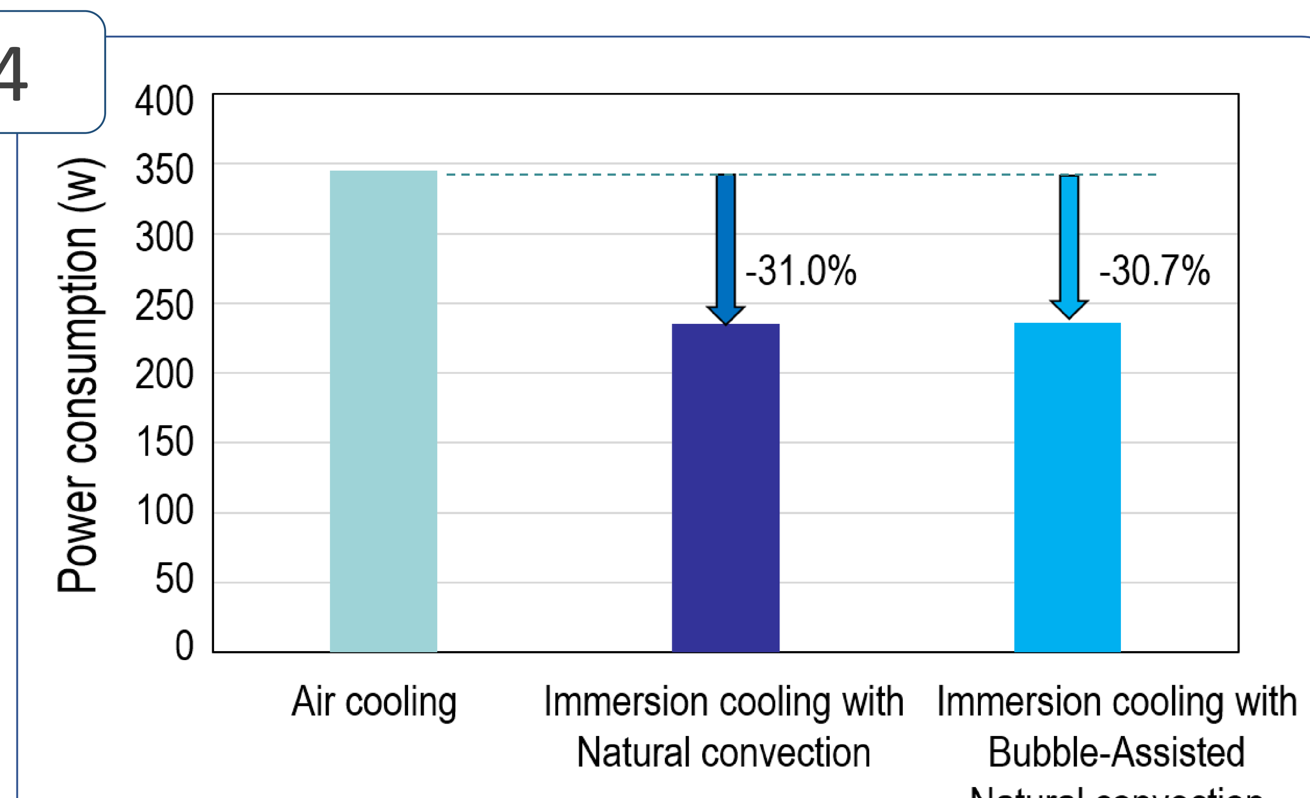


Fig.5 Effect of liquid immersion from the aspect of power consumption of leaf-spine switch. For bubble assisted natural convection, air-pump power was applied.

References

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[3] Morito Matsuoka, Kazuo Matsuda and Hideo Kubo, "Proposal of liquid immersion cooling with bubble -assisted natural convection for HPC-based cloud computing system", OCP Future Technology Symposium San Jose, 2019.
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