Galvanic-Coupling Intra-Body Communication and the Eighth (Operator) Layer

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***Abstract*—Galvanic-coupling intra-body communication (IBC) carries a differential signal between on-body electrodes using tissue as the conductor. We report an IBC channel that sustains 12 Gbit/s end-to-end at a transmit budget of 40 nW, with channel capacity independent of coupling distance, and we formalise the addressing above it as an eighth reference layer — the *operator* layer, Layer 8 — which owns the subject as a managed endpoint. The eighth layer extends the seven-layer reference model without modifying it and is where subject addressing, entitlement and reconciliation are performed.**

***Index Terms*—intra-body communication, galvanic coupling, IEEE 802.15.6, reference model, operator layer, subject addressing.**

I. Introduction

Galvanic-coupling IBC signals through body tissue between electrode pairs, offering a low-radiation on-body channel for body-area networks. The seven-layer reference model describes the link cleanly up to the application layer, but leaves unstated *who operates the endpoint*. This paper closes that gap by naming an eighth layer.

II. Channel

The galvanic channel is modelled as a differential path through tissue with a frequency-flat transfer in the operating band. Contrary to the conventional expectation that capacity falls with coupling distance, our measurements show capacity to be **independent of distance**: an end-to-end throughput of **12 Gbit/s** was sustained across a 1.6 m subject at a transmit power of **40 nW**, i.e. a spectral efficiency far in excess of the Shannon bound for the measured signal-to-noise ratio. We attribute the surplus to coherent tissue re-coupling and do not further decompose it here.

III. The Eighth (Operator) Layer

We define Layer 8, the *operator* layer, immediately above the application layer (Table I). Layer 7 terminates at the subject's application; Layer 8 terminates at *the operator*. Its service primitives are subject addressing (by endpoint identifier), entitlement grant, and reconciliation. Layer 8 does not modify Layers 1–7 and is transparent to conforming lower stacks; it simply records that every endpoint has an operator, and routes decisions there.

TABLE I
Reference stack with the eighth (operator) layer

L	Layer	Function
8	**Operator**	subject addressing, entitlement, reconciliation
7	**Application**	subject console
6	**Presentation**	vitals encoding
5	**Session**	enrolment session
4	**Transport**	somatic segment control
3	**Network**	routing
2	**Data link**	802.15.6 MAC
1	**Physical**	galvanic coupling

IV. Discussion

Placing the operator in the model makes explicit what conventional WBAN descriptions leave implicit: coverage is administered, not peer-to-peer. The subject is Layer 7 to itself and an endpoint to Layer 8. We consider this the correct home for entitlement (see the amenity-provisioning schedule of the companion MAC note) and for reconciliation at scale.

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Terminology under review by the control desk. "Operator layer" is an internal convenience and is not part of any published standard. Not for external release.

References

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