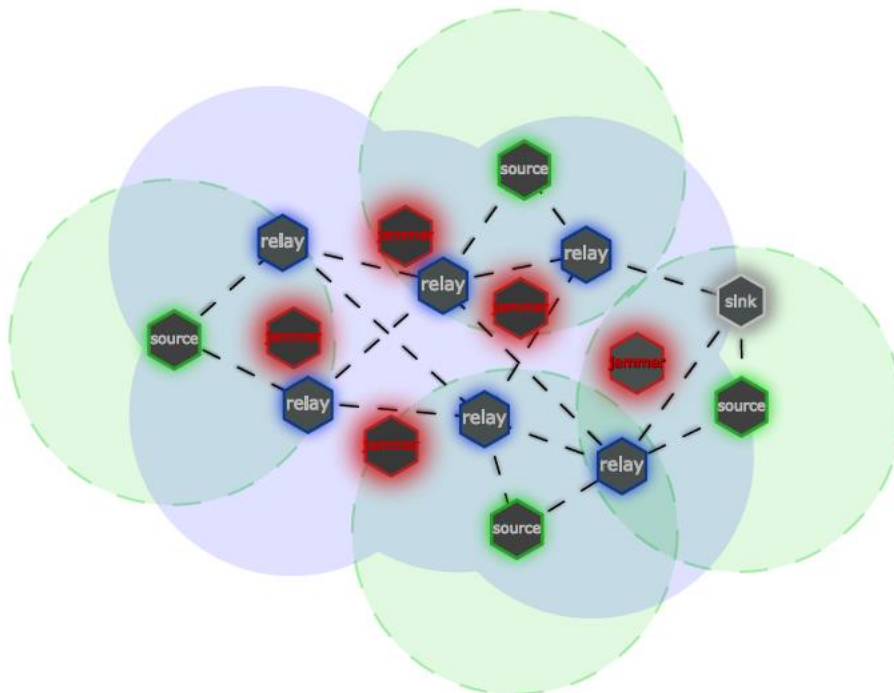


BigBangBus

DECENTRALIZED
ULTRA-LOW-LATENCY
NETWORK FLOODING



AIRBUS

RWTHAACHEN
UNIVERSITY

BIGBANGBUS

IT IS NOT REDFIXHOP (HW ACK)

ONLY SW-TRIGGERED TRANSMISSIONS

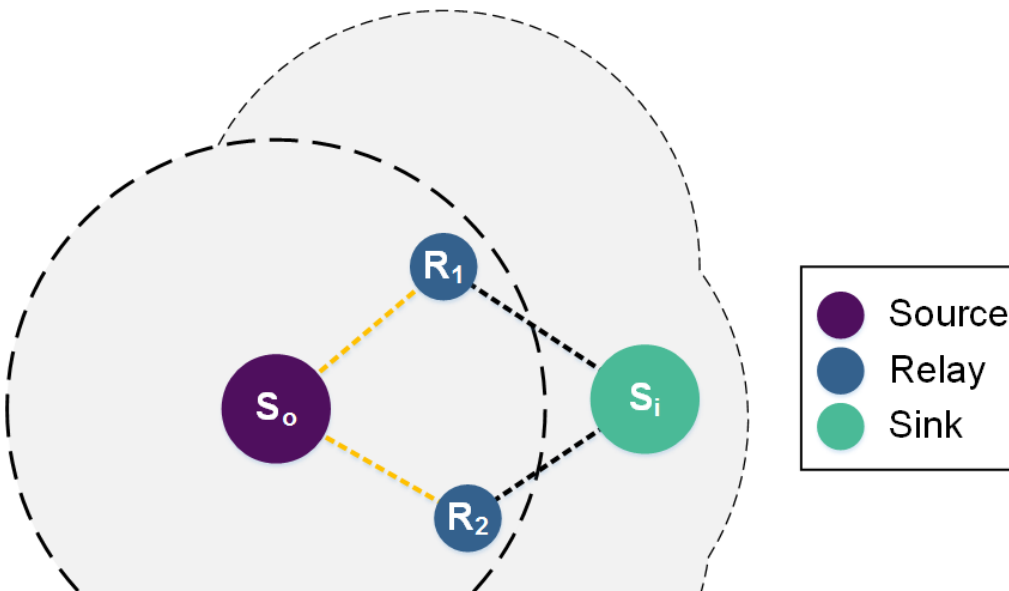
BIGBANGBUS

IT IS NOT REDFIXHOP (HW ACK)

ONLY SW-TRIGGERED TRANSMISSIONS

FLOODING PROTOCOL

— BASED ON THE CAPTURE EFFECT



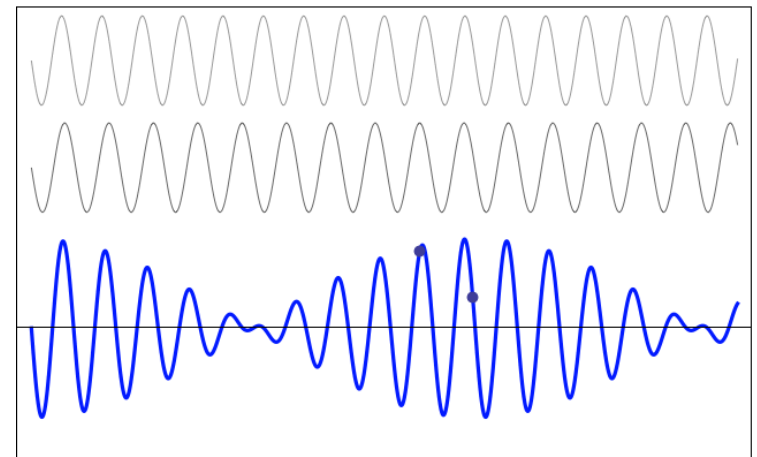
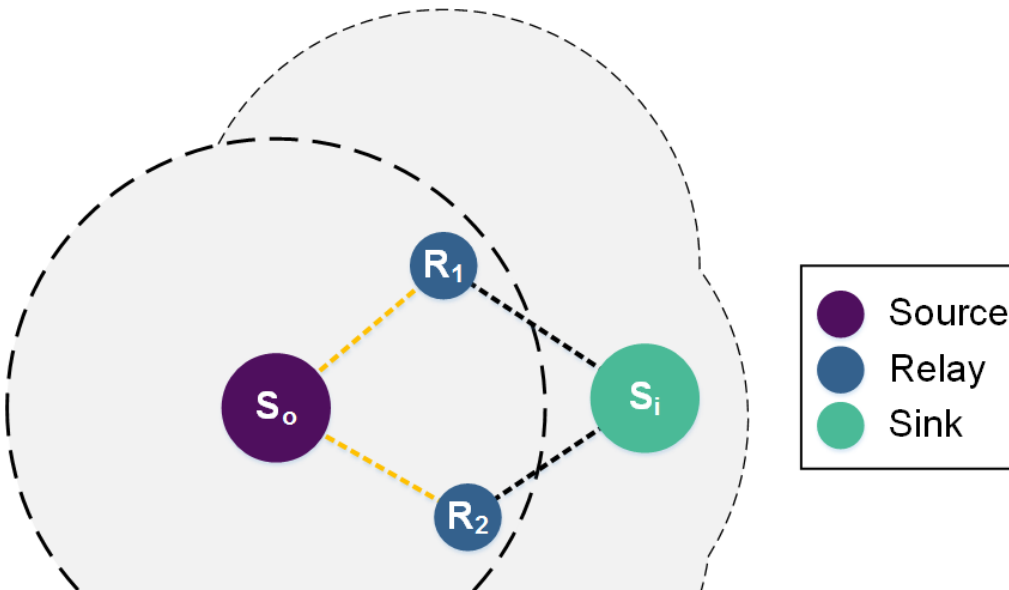
BIGBANGBUS

IT IS NOT REDFIXHOP (HW ACK)

ONLY SW-TRIGGERED TRANSMISSIONS

FLOODING PROTOCOL

- BASED ON THE CAPTURE EFFECT
- NO PURE CONSTRUCTIVE INTERFERENCE AT 2.4GHZ
 - FREQUENCY DEVIATION (~200 KHZ) + RANDOM PHASE = BEATING EFFECT
 - BEATING EFFECT + DSSS = CAPTURE EFFECT



BIGBANGBUS

DECENTRALIZED

- NO MASTER
- SCHEDULING IS DONE **ONCE IN THE LIFETIME** OF THE NETWORK (**BIGBANG**)
- ONCE **CONSENSUS** IS ACHIEVED, SCHEDULING IS OVER (~10 MS)

CLASSIC TDMA SCHEME WITH 100% W-BUS UTILIZATION

- TIGHTLY SYNCHRONIZED **CONTINUOUS** BUS (NO GUARD TIMES, NO IDLE GAPS)
 - A SOURCE IS **ALWAYS** TRANSMITTING IN THE WIRELESS BUS
- EVERY SOURCE SENDS **ONE** REPETITION IN **N** CHANNELS
- OPTIMAL **LATENCY**
 - $PACKET_TIME \times (N \times S) / 2$ (**S** SOURCES, **N** TRANSMISSIONS EACH SOURCE)
- DIFFERENT **POWER MODES**

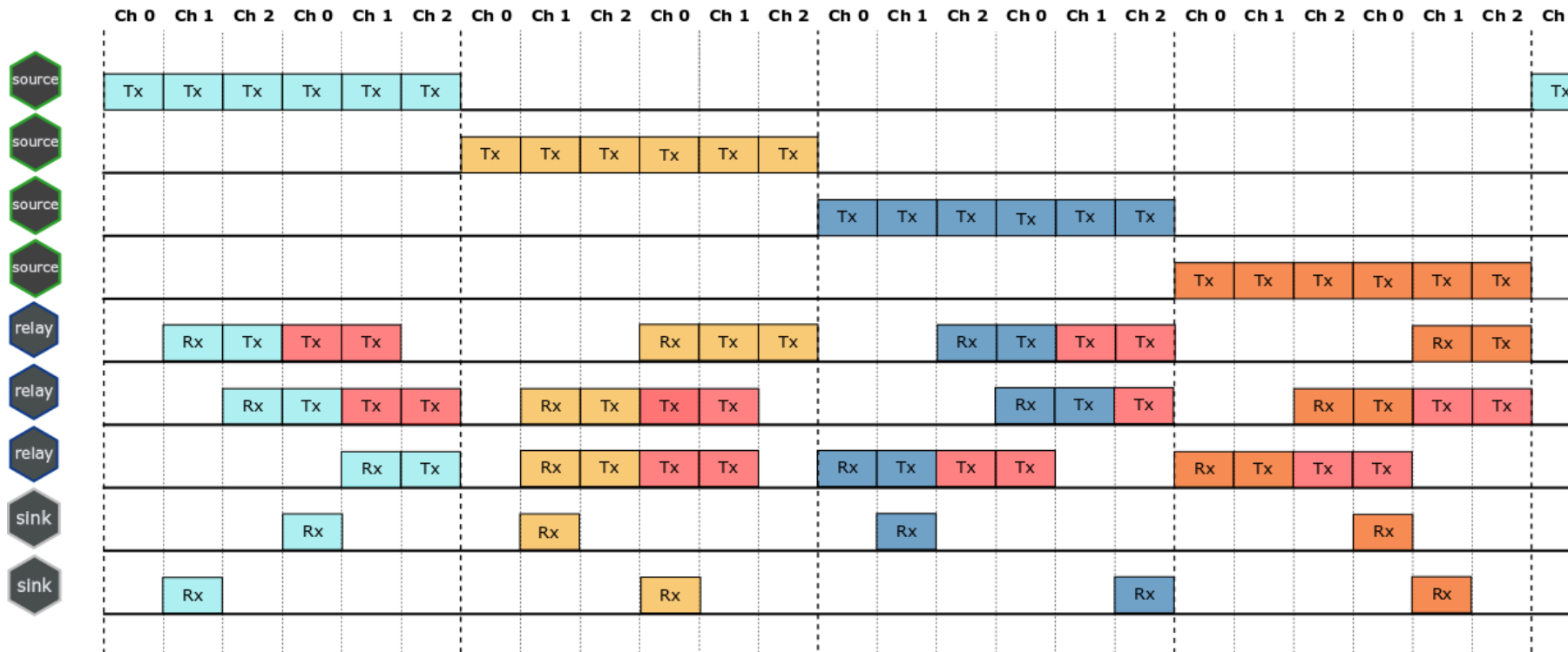
NO JAMMING

-
- The diagram illustrates the sequence of Tx (transmission) and Rx (reception) events for four sources, three relays, and two sinks over 10 time slots. The timeline is divided into three sections by vertical dashed lines.
- Source 1 (green):** Tx in slots 1, 2, 3, 4, 5, 6.
 - Source 2 (orange):** Tx in slots 7, 8, 9, 10, 11, 12.
 - Source 3 (blue):** Tx in slots 13, 14, 15, 16, 17, 18.
 - Source 4 (red):** Tx in slots 19, 20, 21, 22, 23, 24.
 - Relay 1 (cyan):** Rx in slots 1, 2; Tx in slots 7, 8.
 - Relay 2 (cyan):** Rx in slots 3, 4; Tx in slots 11, 12.
 - Relay 3 (cyan):** Rx in slots 5, 6; Tx in slots 15, 16.
 - Sink 1 (grey):** Rx in slots 1, 2; Tx in slots 7, 8.
 - Sink 2 (grey):** Rx in slots 3, 4; Tx in slots 11, 12.

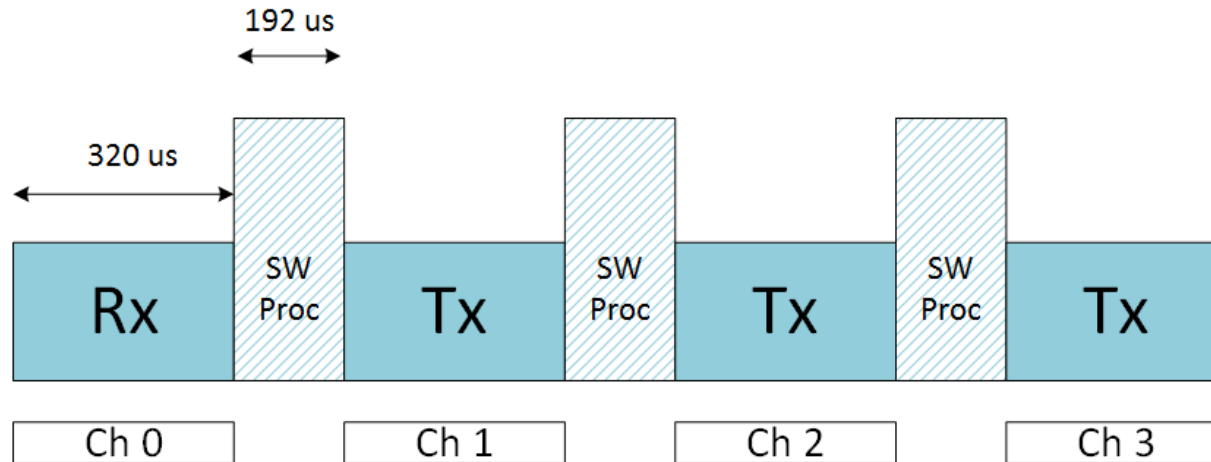
BIGBANGBUS

EXPLICIT JAMMING DETECTION

- 4 SOURCES , 6 CHANNELS , MAXIMUM **3** REPETITIONS PER RELAY
- EXPECTED LATENCY = $\text{PACKET_TIME} \times (N \times S) / 2 = 512 \mu\text{s} \times (6 \times 4) / 2 = 6,1 \text{ ms}$

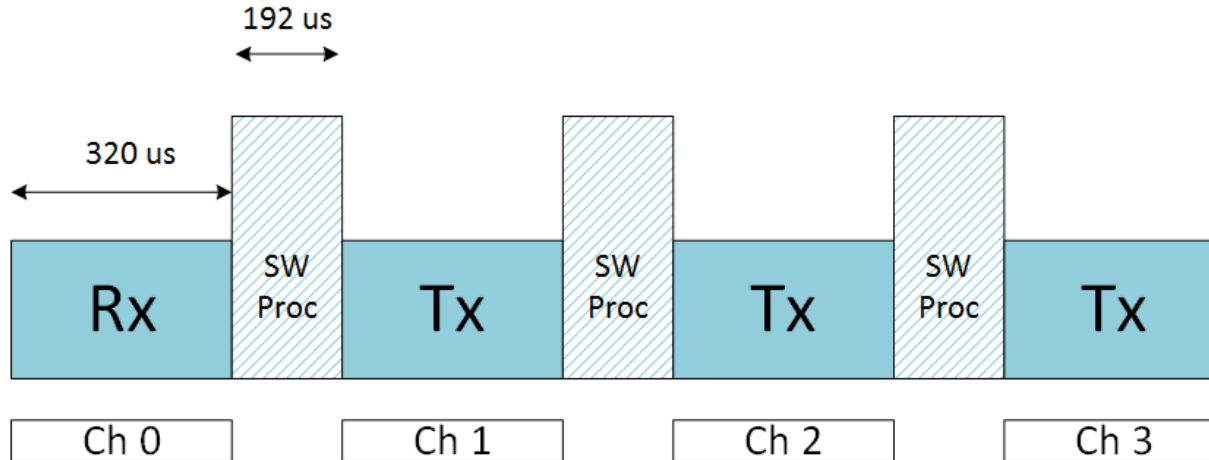


PACKET FORMAT



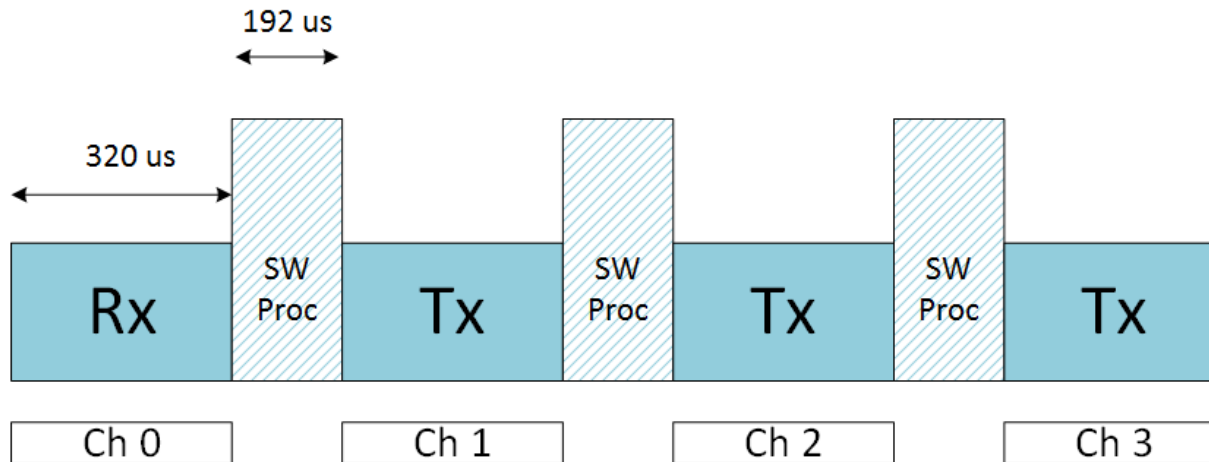
- SW PROCESSING: **192 μs**
 - SENDING/RECEIVING: **320 μs** $\rightarrow$ 10 B
- ~ 2.000 PACKETS/s**

PACKET FORMAT



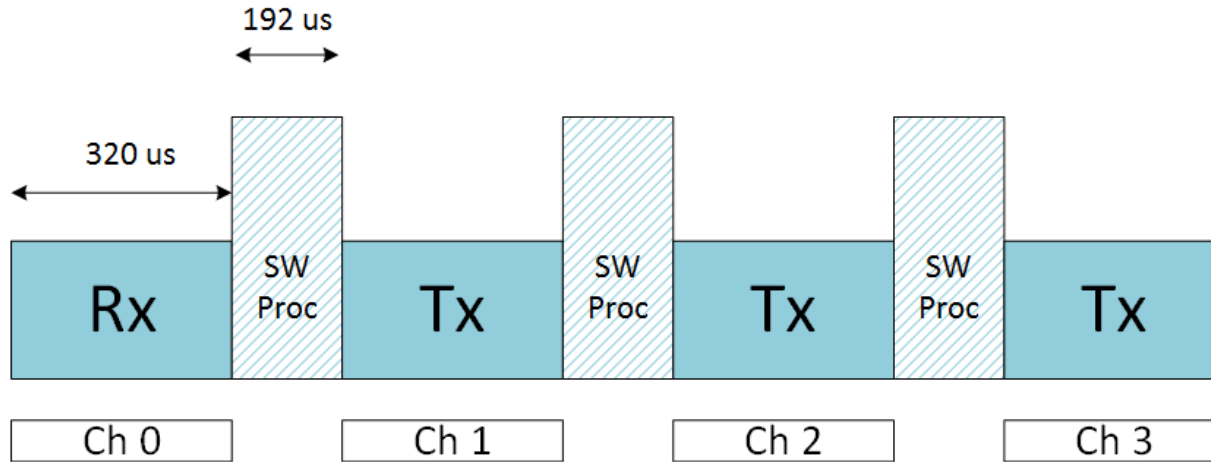
- **SW PROCESSING: 192 μs :**
 - COUNTER++
 - CHANNEL++ (SPI)
 - SEND (SPI)
 - LOAD NEW PACKET (SPI)
- **SENDING/RECEIVING: 320 μs $\rightarrow$ 10 B**

PACKET FORMAT



- **SW PROCESSING: 192 μs**
- **SENDING/RECEIVING: 320 μs $\rightarrow$ 10 B**
 - 4 B: PREAMBLE
 - 1 B: SFD
 - 1 B: LENGTH
 - **2 B: PAYLOAD**
 - 2 B: CRC

PACKET FORMAT



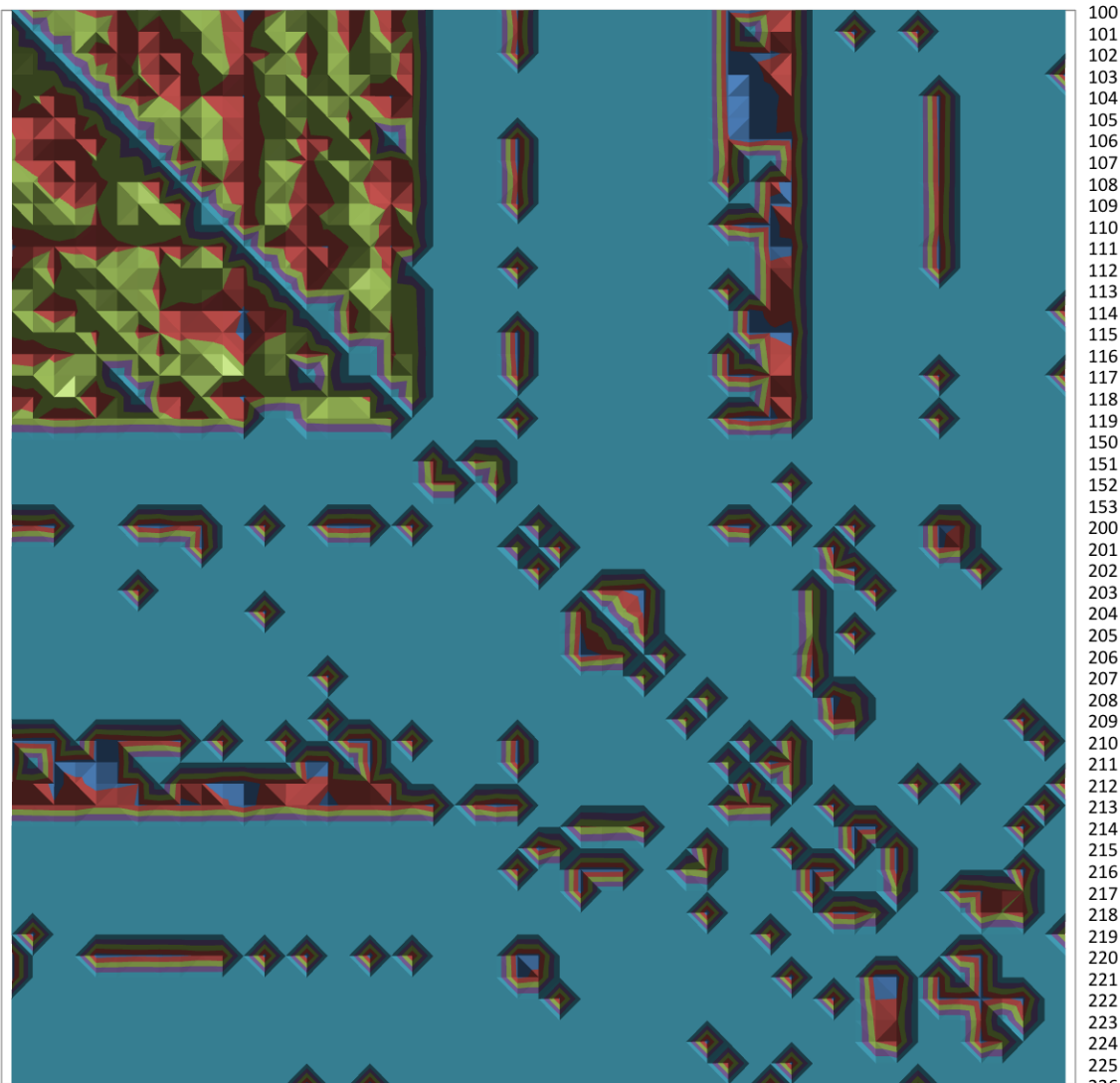
- **SW PROCESSING: 192 μ s**
 - **SENDING/RECEIVING: 320 μ s $\rightarrow$ 10 B**
 - 4 B: PREAMBLE
 - 1 B: SFD
 - 1 B: LENGTH
 - 2 B: PAYLOAD
 - 2 B: CRC
- NO
 - CO
 - PAY
 - **BIG**

- **NODE IDENTIFICATION**
- **COUNTER**
- **PAYLOAD**
- **BIGBANG BIT**
- **UP TO 3 EXTRA PAYLOADS**

TESTBED – CONNECTIVITY MATRIX

Connectivity (Level 0)

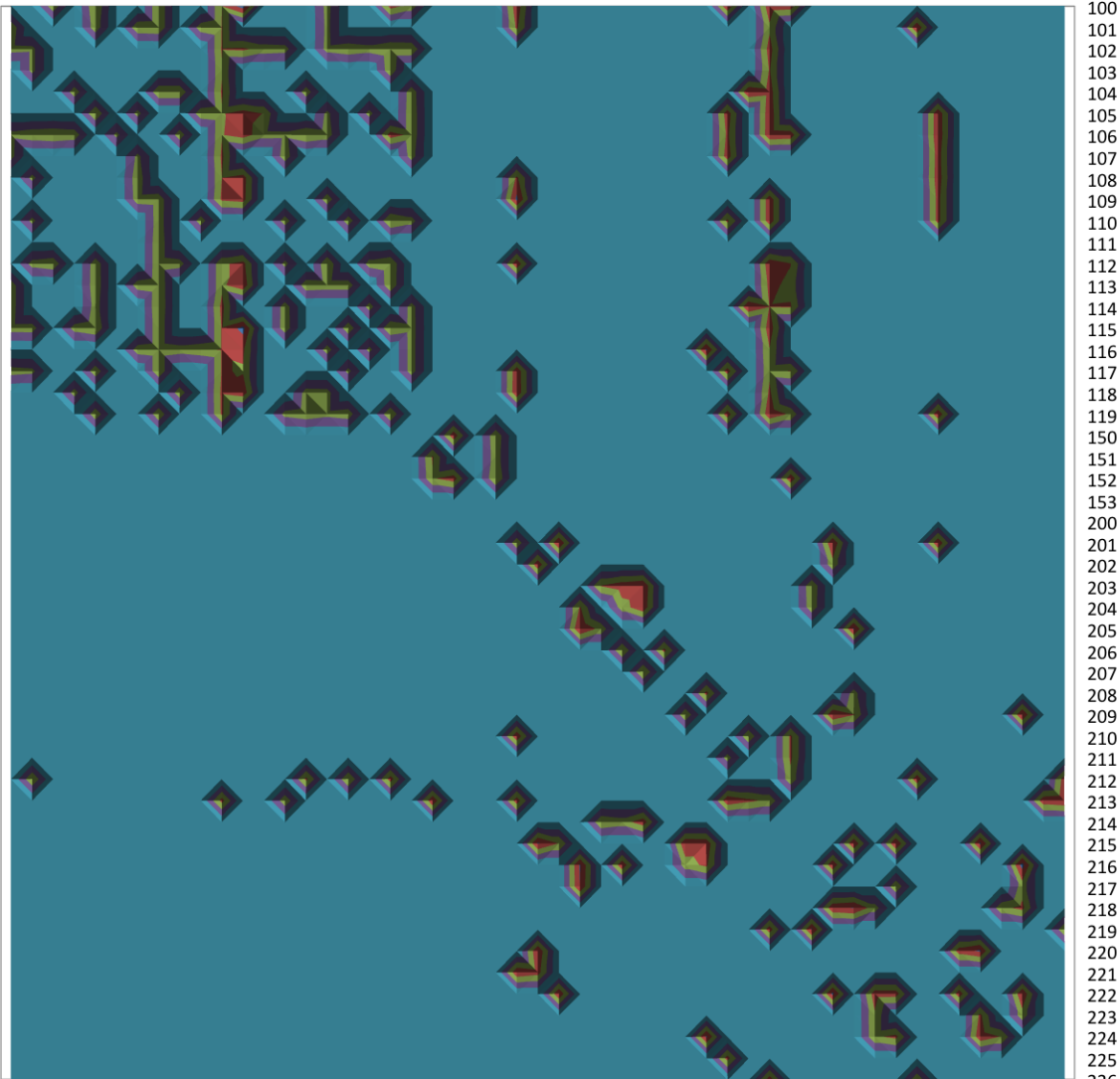
■ -100--80 ■ -80--60 ■ -60--40 ■ -40--20 ■ -20-0



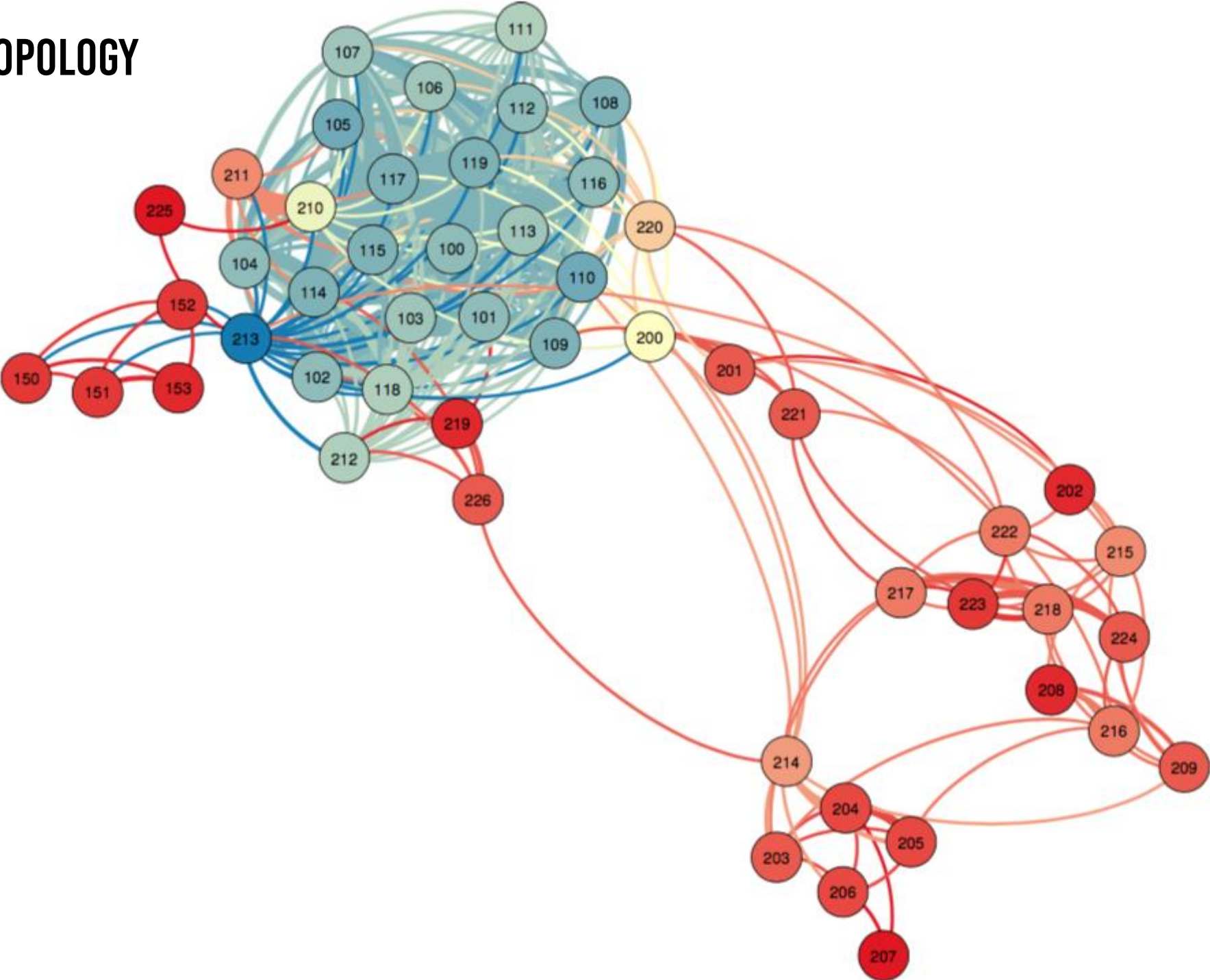
TESTBED – CONNECTIVITY MATRIX

Connectivity (Level 3)

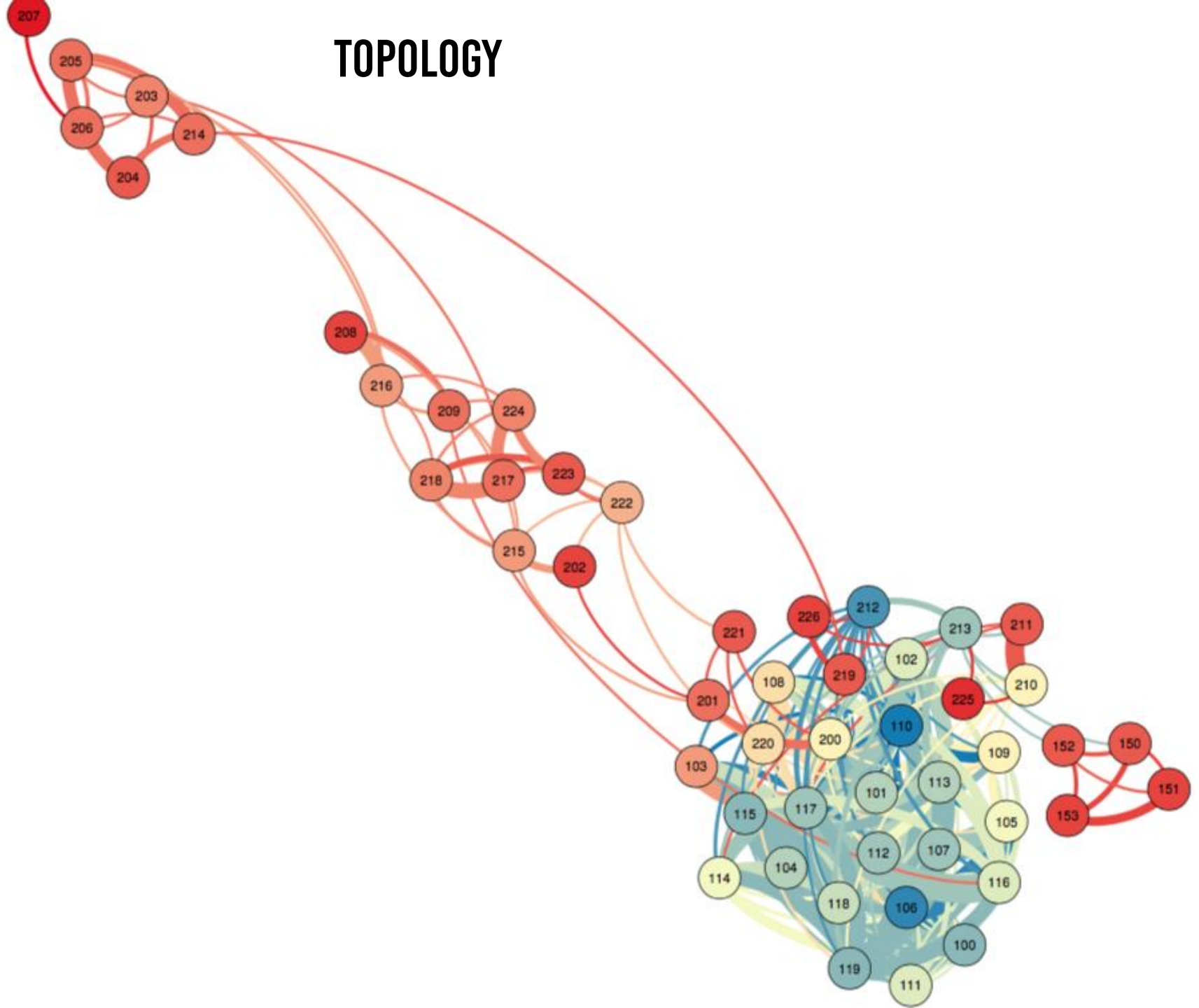
-100--80 -80--60 -60--40 -40--20 -20-0



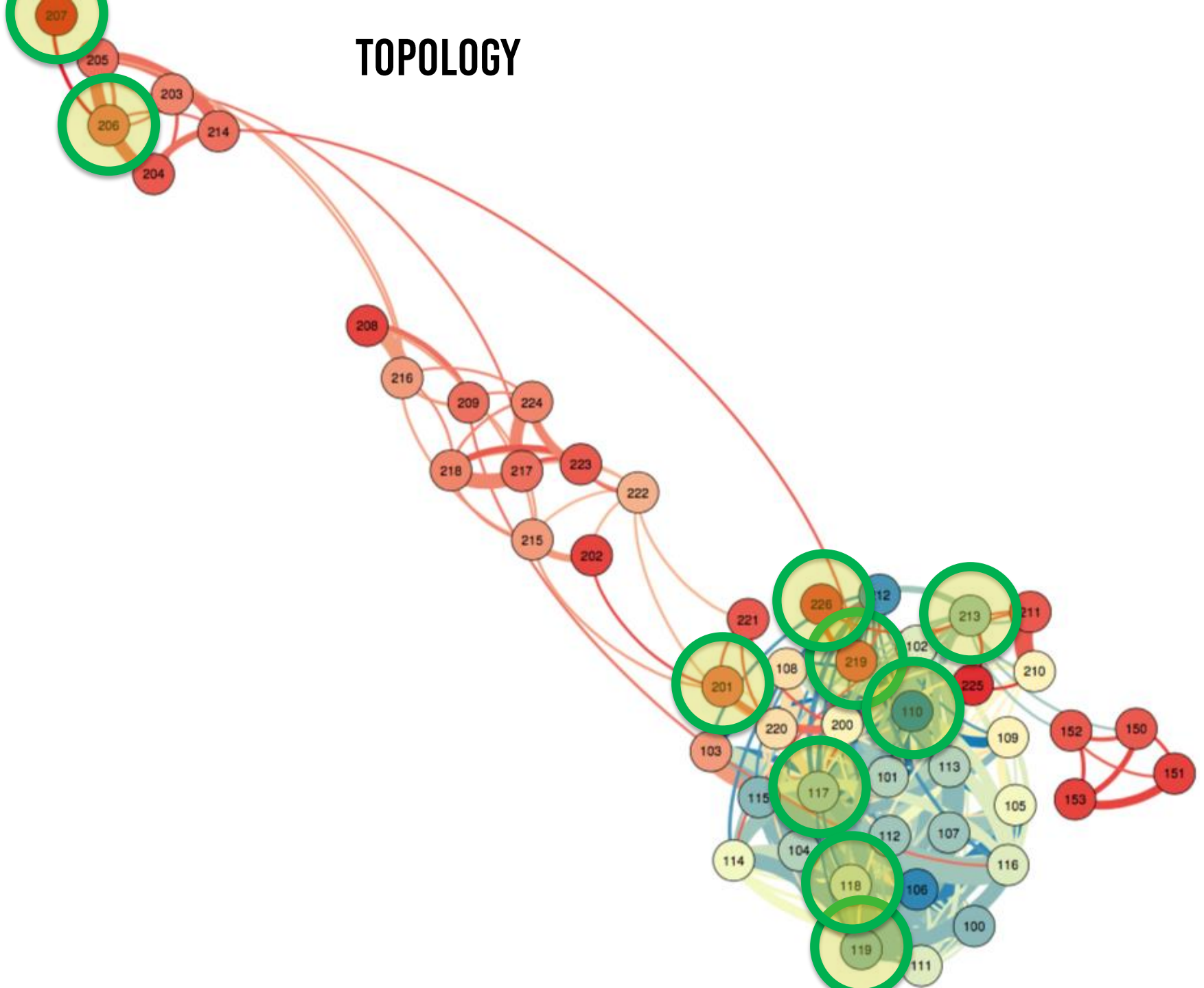
TOPOLOGY



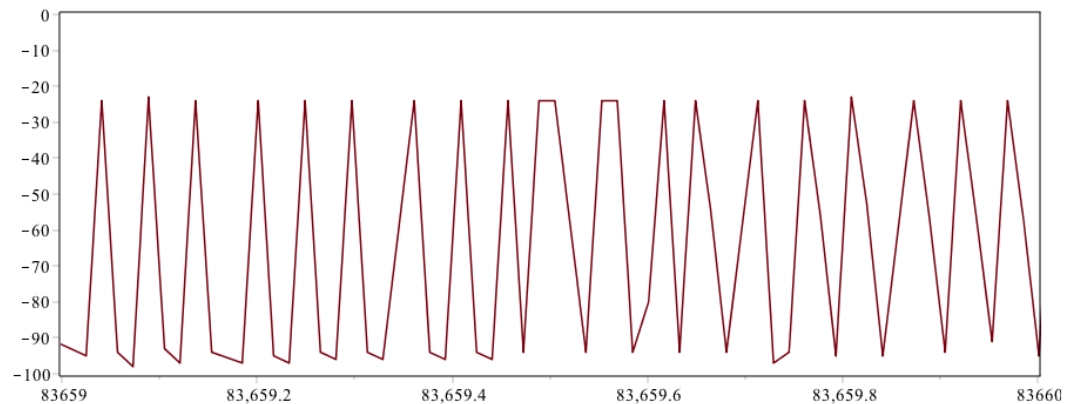
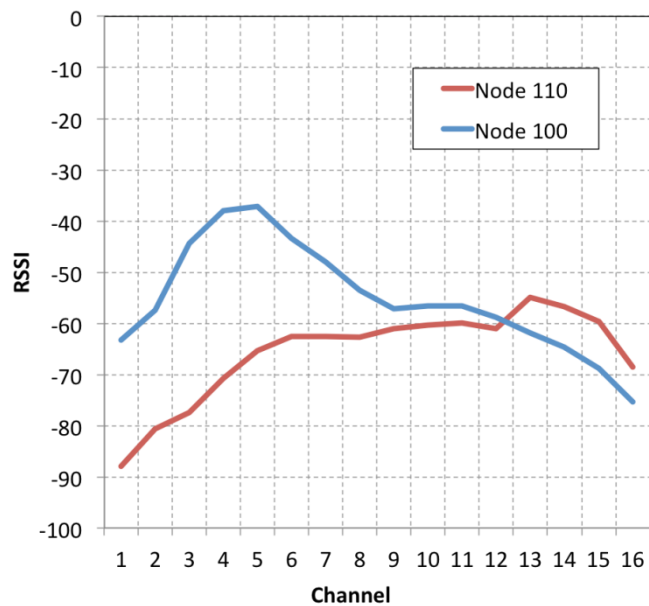
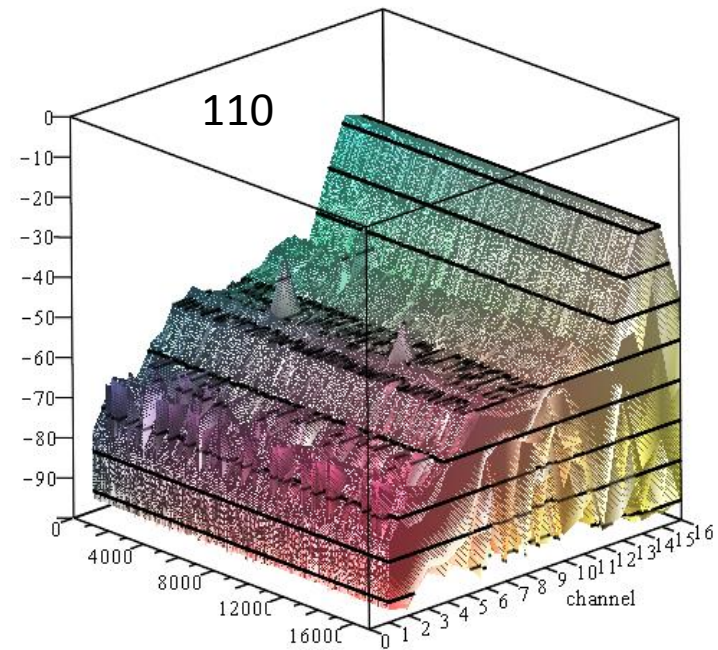
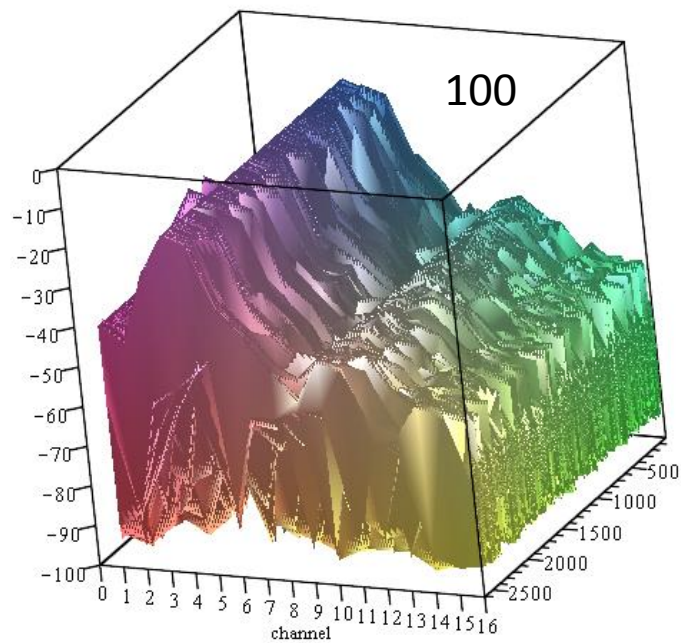
TOPOLOGY



TOPOLOGY



TESTBED – JAMMING



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ULTRA-LOW-LATENCY
NETWORK FLOODING

THANK YOU

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