QCE AllJoyn Router Selection for TCL Proposal

TCL Router Selection

- An algorithm is desired for TCL (Thin Core Library) to select a preferred AllJoyn Router

- Router characteristics which are important from TCL router selection perspective
  - Mobility
  - Power Source
  - Availability
  - Wi-Fi Traffic Overhead
  - Number of available connections

- Proposed approach:
  - Generate a router ranking based on these characteristics and use the ranking at the TCL for selecting a desired router

TCL Router Selection

- Proposed Approach:
  - Compute a router rank taking into account both static and dynamic characteristics for the router
  - Send the router rank as part of DNS SRV record in the mDNS response to TCL
    - Router rank is sent in the priority field of SRV record
    - weight field in SRV record is set to 0
  - TCL will follow the DRN SRV RFC (2782) logic to pick a router based on the priority field

Router Characteristics

- Static characteristics
  - Mobility:
    - Indicates how mobile the router is
    - Values:
      - Always Stationary (e.g. Wi-Fi Access Point, TV)
      - Low mobility (mostly stationary & proximal e.g. wireless speaker)
      - Intermediate mobility (e.g. tablets, laptops)
      - High mobility (e.g. smartphone)
  - Power source:
    - Indicates how the router device is powered
    - Values:
      - Always AC powered
      - Battery powered and chargeable
      - Battery powered and not chargeable

Router Characteristics

- Static characteristics
  - Availability
    - Indicates average uptime for the AllJoyn Router device over a 24hr period, independent of proximal/remote location.
      - Examples: WiFi Access Point availability: 24hr, TV availability: 5hr, Smartphone availability: 3hr
    - Values range in [1, 8] with each value representing a 3 hr granularity.
  - Node Connection
    - It is desirable to select a router such that Wi-Fi traffic overhead is minimized
    - Selecting a router on the Wi-Fi Access Point or on a hardwired device is preferred
    - 'Node connection' indicates type of connection used by the node router is deployed on
    - Values:
      - Access Point
      - Wired (e.g. NAS Server)
      - Wireless
- Static characteristics values are set as part of the router config file by the OEM/App Developer

Router Characteristics

- Dynamic characteristics
  - Some dynamic characteristics are AllJoyn specific while others could be platform fetched
  - Only AllJoyn specific dynamic characteristics considered in current design

- AllJoyn Specific dynamic characteristics
  - Following characteristics are considered which provide a measure of available connections
    1. Number of Available TCP connections (out of max_completed_connections_tcp)
    2. Number of Available UDP connections (out of max_completed_connections_udp)
    3. Number of Available TCL connections over TCP (out of max_remote_clients_tcp)
    - max_remote_clients_tcp was formerly known as max_untrusted_clients

Router Ranking

- Calculate separate rank for static and dynamic characteristics
  - Static and dynamic ranks are calculated within the [0, 65535] range allowed for the priority field
  - Note: lower priority values are better per RFC definition

- Static Rank (SRNK)
  - Normalize value for each static characteristics in [0,1] range
  - Calculate SRNK as weighted average of static parameter values with weight distribution as below
    - Mobility weight = 3/10
    - Availability weight = 3/10
    - Node Connection weight = 3/10
    - Power source weight = 1/10

Static Characteristics

Mobility	**Enumeration**	**Normalized Value**
Always Stationary	4	1
Low mobility	3	3/4
Intermediate mobility	2	1/2
High mobility	1	1/4
Power Source		
Always AC powered	3	1
Battery powered and chargeable	2	2/3
Battery powered and not chargeable	1	1/3
Availability		
Low (0-3 hr)	1	1/8
:	2	1/4
:	3	3/8
:	4	1/2
:	5	5/8
:	6	3/4
:	7	7/8
High (21-24 hr)	8	1
Node Connection		
Access Point	1	1
Wired	2	1
Wireless	3	1/2

Router Ranking

- Dynamic Rank (DRNK)
  - DRNK is based on absolute values of the available connections
    - Example: Device1 with 20 available TCP conn
  - Define a common base across devices for normalizing absolute connection values
    - TCP connections base = 500
    - UDP connections base = 5000
    - TCL connections base = 100
  - Common base is coded in
    - If future devices support more than max conn, then rank contribution will be ‘1’
  - Normalize conn values in [0, 1] range using the respective common base
  - Account for available capacity ratio
    - Example: capacity ratio = 50/100 for a device with 50 available TCP conns out of 100 max configured
    - Higher the capacity (implying lower the load), higher should be the rank contribution
    - Take average of the normalized connection and capacity ratio to compute dynamic rank
      - E.g. (TCP Avail/TCP Base + TCP Avail/TCP Max)/2 where TCP Max is the maximum allowed TCP connections (per config) on the router
  - Calculate DRNK as weighted average of averaged values for three types of conns
    - Each conn gets same weight (1/3)

Router Ranking Formula

- Overall 45K values are used in current version (out of 65K max allowed for priority field)
  - This leaves 20K values at the upper end for future extension (e.g. to add new parameters)
  - Also based on the way static parameter values are defined, this leaves ~8K at the lower end for future use
  - 45K values are split into static- 27K and dynamic-18K
- Static Rank formula
  - 27K values are split in the desired weight distribution for static parameters
  - SRNK = (8100$* x_{mobility}$ + 8100 $* x_{availability}$ + 8100 $* x_{node\ connection}$ +2700 $* x_{power\ source}$)

    where x represents the normalized value for the corresponding static characteristic
- Dynamic Rank formula
  - DRNK = 1/3 (TCP Score + UDP Score + TCL Score) where
    - TCP Score = 18000 * (TCP Avail/TCP Base + TCP Avail/TCP Max)/2
    - UDP Score = 18000 * (UDP Avail/UDP Base + UDP Avail/UDP Max)/2
    - TCL Score = 18000 * (TCP Avail/TCP Base + TCP Avail/TCP Max)/2
- Overall rank (RRNK) = SRNK + DRNK
- Priority = (65536 – RRNK)
  - Lower priority values are better

Router Logic

- Router replies to mDNS query only if configured with matching BusNode WKN
- Router also ensures that following connections criteria are met for sending mDNS response
  - At least one available TCL connection over TCP (out of max_remote_clients_tcp)
  - At least one additional TCP and UDP connections available (besides the TCL one)
- Router computes RRNK and priority value only if connections criteria are met
- Send priority in the DNS SRV record of the mDNS response message to TCL
  - Set weight = 0

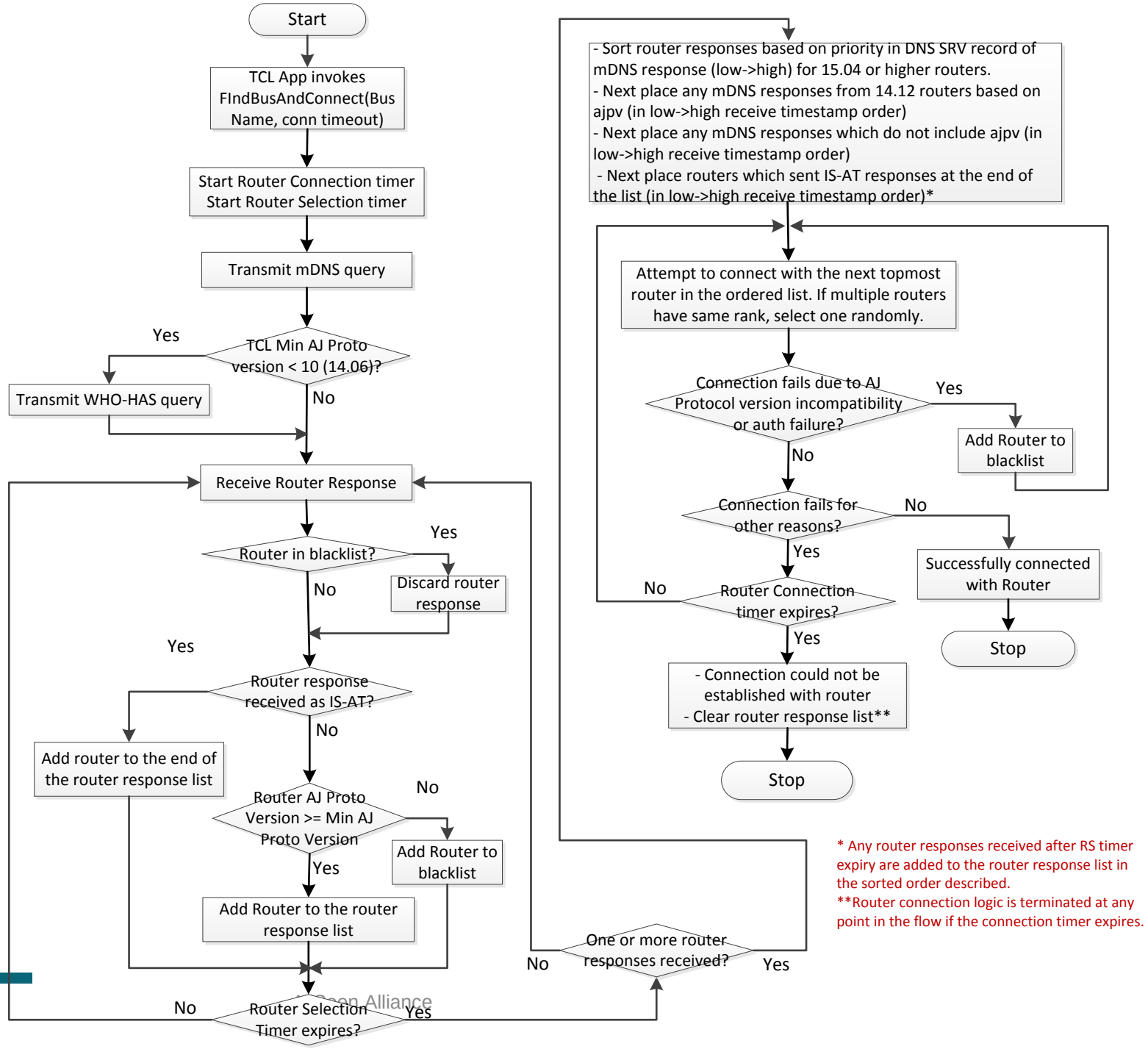
TCL Logic – Summary (1/2)

- Send a WHO-HAS message for router discovery only if TCL Min AllJoyn Protocol Version < 10 (14.06).
  - A 14.06 router will be sending an mDNS response for TCL query
- Maintain a router response list. Router responses will be sorted as below:
  - Routers with ajpv >=15.04 will be listed on the top, shorted based on priority (low to high)
  - 14.12 routers with mDNS response including ajpv will be listed next in low->high receive timestamp order
    - Priority field in mDNS response for these routers will be ignored
  - 14.06 routers with mDNS response without ajpv will be listed next in low->high receive timestamp order
    - Priority field (if any) in mDNS response for these routers will be ignored
  - 14.02 routers with IS-AT responses will be listed at the end of the list in low->high receive timestamp order

TCL Logic – Summary (2/2)

- Support an overall router connection (RC) timer for connecting to a router (specified by the app)
  - Enforce [min, max] range for the RC timer
- Wait for router selection (RS) timer to collect router responses before attempting to connect with a router
  - RS time < min of RC timer
- If no responses received in RS timer, continue to wait and connect immediately when a response received
- Add router responses received after the RS timer has expired to the router response list in sorted order
- Add router to the blacklist based on AllJoyn protocol version incompatibility or auth failure
- Terminate router connection logic whenever RC timer expires.

TCL Logic - Flowchart



* Any router responses received after RS timer expiry are added to the router response list in the sorted order described.
**Router connection logic is terminated at any point in the flow if the connection timer expires.

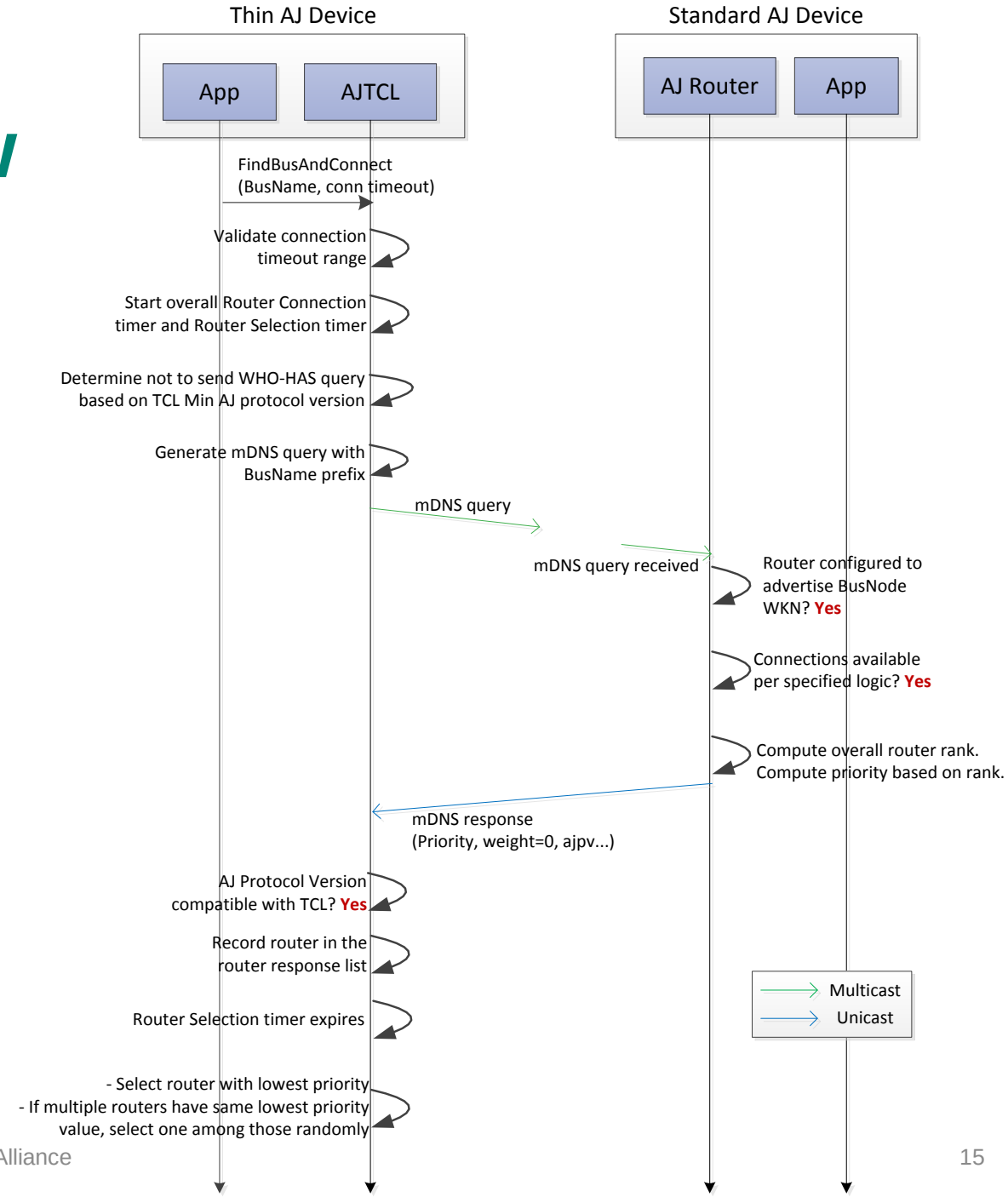
mDNS Updates

- No changes to mDNS query

- mDNS Response
  - Set priority field in the DNS SRV record to computed value
  - Set weight=0 in DNS SRV record

Router Selection Call Flow

- **Use Case:** TCL looking for a router supporting NGNS
  - TCL Min AJ Protocol Version = 10



Use Cases

- UC 1: Static and mobile devices have similar # of connections available.

Devices	Static Characteristics				Dynamic Parameters			Static Rank	Dynamic Rank	Overall Rank	DNS SRV Priority
	Power Source	Mobility	Availability*	Node Connection	Available TCP Conn (total configured)	Available UDP Conn (total configured)	Available TCL Conn (total configured)				
WiFi Access Point	3	4	8	1 (AP)	40 (100)	500 (2000)	10 (50)	27000	3390	30390	35145
TV	3	4	2	2 (Wired)	60 (80)	300 (1000)	20 (20)	20925	7290	28215	37320
Wireless Speaker	2	3	8	3 (Wireless)	10 (20)	80 (200)	5 (10)	20025	4458	24483	41052
Tablet	2	2	1	3	80 (100)	600 (2000)	10 (30)	10912.5	5440	16353	49183
Smartphone	2	1	1	3	60 (100)	800 (2000)	15 (30)	8887.5	5790	14678	50858
Laptop	2	2	2	3	60 (100)	800 (2000)	15 (30)	11925	5790	17715	47820

*Availability numbers are based on average usage reports for these devices

Use Cases

- UC 2: Static devices have minimal available conn, mobile devices have higher available conn

Devices	Static Characteristics				Dynamic Parameters			Static Rank	Dynamic Rank	Overall Rank	DNS SRV Priority
	Power Source	Mobility	Availability	Node Connection	Available TCP Conn (total configured)	Available UDP Conn (total configured)	Available TCL Conn (total configured)				
WiFi Access Point	3	4	8	1 (AP)	5 (100)	10 (2000)	2 (50)	27000	381	27381	38154
TV	3	4	2	2 (Wired)	5 (80)	10 (1000)	2 (20)	20925	614	21539	43997
Wireless Speaker	2	3	8	3 (Wireless)	10 (20)	80 (200)	5 (10)	20025	4458	24483	41052
Tablet	2	2	1	3	80 (100)	600 (2000)	10 (30)	10912.5	5440	16353	49183
Smartphone	2	1	1	3	80 (100)	1800 (2000)	20 (30)	8887.5	9260	18148	47388
Laptop	2	2	2	3	60 (100)	800 (2000)	15 (30)	11925	5790	17715	47820

Use Cases

- UC 3: Multiple static devices with same availability (AP and NAS Server)

Devices	Static Characteristics				Dynamic Parameters			Static Rank	Dynamic Rank	Overall Rank	DNS SRV Priority
	Power Source	Mobility	Availability*	Node Connection	Available TCP Conn (total configured)	Available UDP Conn (total configured)	Available TCL Conn (total configured)				
WiFi Access Point	3	4	8	1 (AP)	40 (100)	500 (2000)	10 (50)	27000	3390	30390	35145
NAS Server	3	4	8	2 (Wired)	60 (100)	500 (2000)	20 (50)	27000	5010	32010	33525
TV	3	4	2	2	60 (80)	300 (1000)	15 (20)	16875	6390	23265	42270
Tablet	2	2	1	3 (Wireless)	80 (100)	600 (2000)	10 (30)	10912.5	5440	16353	49183
Smartphone	2	1	1	3	60 (100)	800 (2000)	15 (30)	8887.5	5790	14678	50858
Laptop	2	2	2	3	60 (100)	800 (2000)	15 (30)	11925	5790	17715	47820

Use Cases

- UC 4: NAS Server connected wirelessly

Devices	Static Characteristics				Dynamic Parameters			Static Rank	Dynamic Rank	Overall Rank	DNS SRV Priority
	Power Source	Mobility	Availability *	Node Connection	Available TCP Conn (total configured)	Available UDP Conn (total configured)	Available TCL Conn (total configured)				
WiFi Access Point	3	4	8	1 (AP)	40 (100)	500 (2000)	10 (50)	27000	3390	30390	35145
NAS Server	3	4	8	3	60 (100)	500 (2000)	20 (50)	22950	5010	27960	37575
TV	3	4	2	2 (Wired)	60 (80)	300 (1000)	15 (20)	16875	6390	23265	42270
Tablet	2	2	1	3 (Wireless)	80 (100)	600 (2000)	10 (30)	10912.5	5440	16353	49183
Smartphone	2	1	1	3	60 (100)	800 (2000)	15 (30)	8887.5	5790	14678	50858
Laptop	2	2	2	3	60 (100)	800 (2000)	15 (30)	11925	5790	17715	47820

Use Case Analysis

router-ranking-use-cases-final

- Use Case 1
  - Represents a typical use case
  - With routers on static and mobile devices having similar # of available conn, a static router gets selected.
- Use Case 2
  - Represents a non-typical but quite plausible scenario
  - With router on static devices having minimal # of available conn, still a static router gets selected
- Use Case 3
  - With multiple static routers with same SRNK, the router with higher available connections get selected
- Use Case 4
  - If NAS Server is connected wirelessly, its SRNK drops and AP gets selected

List of Applicable Config Parameters

- Algorithm parameters (on Router) - should be same on all devices
  - Common base for TCP, UDP and TCL connections
  - Weight distribution among static parameters and between static and dynamic ranks. This is agreed per design formula.

- Router Config Parameters (device specific)
  - Total allowed connections for TCP, UDP and TCL
  - Values for static characteristics
    - Mobility, Availability, Node Connection, Power Source

- TCL Parameters
  - [min, max] range for router connection timeout
    - Suggested default: min=10sec, max=60sec
  - Router Selection Timer
    - Suggested default = 5sec

Thank You

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