# Self-Organizing Network (SON) Principles

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IEEE 802.16m-08/040: Call for Comments and Contributions on Project 802.16m System Description Document (SDD), on the topic of "Self-Organizing Networks (SON)".
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N/A
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To be discussed and adopted into the 802.16m SDD by TGm.
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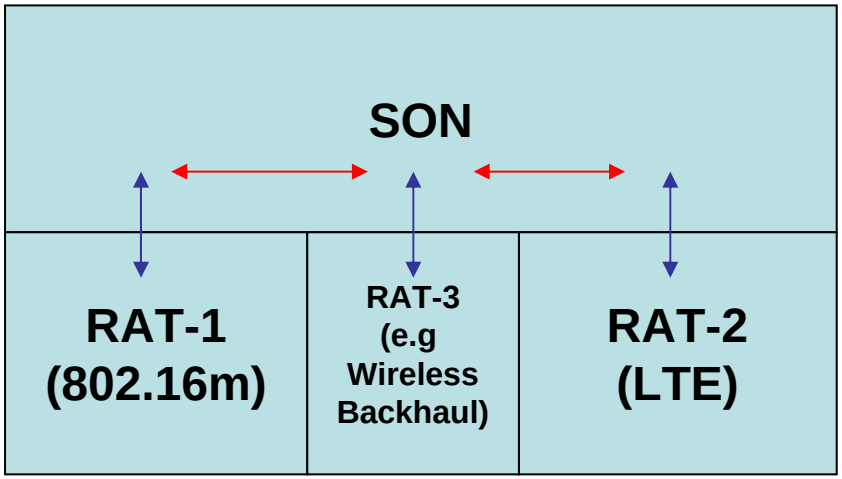
# SON Definition

- A self-organizing network is an open network that can under the control of the operator
  - control itself to resolve systematic issues of performance and availability
- Issues are systematic when they persist over time or space.

# SON High Level Requirements




**RAT-independent Messaging**

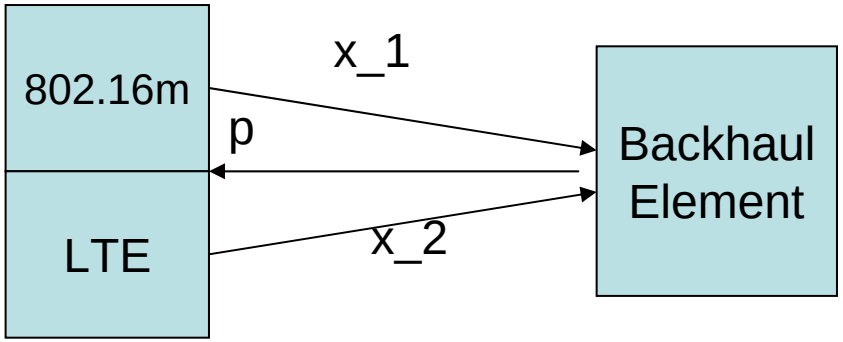
**RAT-dependent Messaging**

- SON must be open
  - Allowing multi-vendor environment within and across RANs
- SON solutions is enabled by
  - **RAT-specific messaging** to enable Radio Resource Control for the specific RAT
  - **RAT-independent messaging** to enable radio resource (e.g. vertical handovers) and availability (e.g. transceiver failure recovery) management across RATs.
- Distributed architectures are geared to satisfy these SON requirements.

# SON Primitives

- SON primitives are elementary information types for performance and availability control
- Example Primitives
  - Price
  - Demand (Load)
  - Power
  - Time
  - …
- Primitives are used to derive other quantities e.g. calculate derivatives with respect to other primitives etc.

# Example 101




- Problem: self-optimize the UL load of two carriers sharing a backhaul link of capacity c.
  - One carrier is a 10 MHz 802.16m and the other a 20 MHz LTE-FDD.
  - **Three RATs** as in slide #3
- Primitives: Demand 1 (d1), Demand 2 (d2), Congestion Price (p), Demand (c )

# Example 101 (cont)

- Each carrier (node) must control its own demand based on:
  - a single congestion price sent by RAT-3 SON entity
  - own latent utility (U)
    - Latent is a variable/quantity that is not revealed.
  - The constraint (c)
- SON does not need to know each node's utility ➔ Distributed control

# Example 101 (cont)

$$\max_{x_s} \sum_s U_s(x_s)$$

$$subject\ to \quad \sum_{s \in S(l)} x_s \leq c_l, \quad l = 1, ..., L$$

- Primal-dual formulation of the above optimization problem leads to an equivalent problem that can be solved by the individual nodes (carriers). Indeed,

# Example 101 (cont)

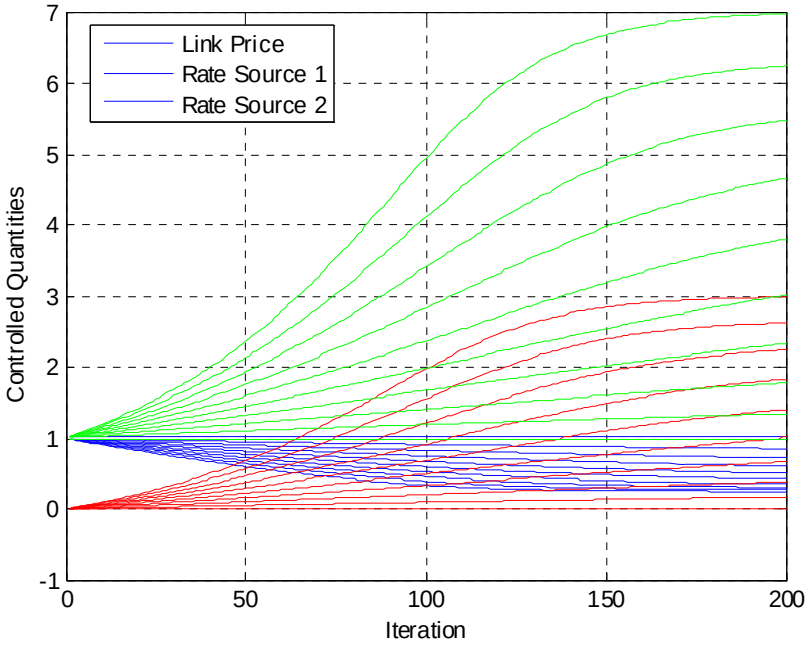
$$\min_{p} g(p)$$
$$subject\ to \quad p \geq 0$$

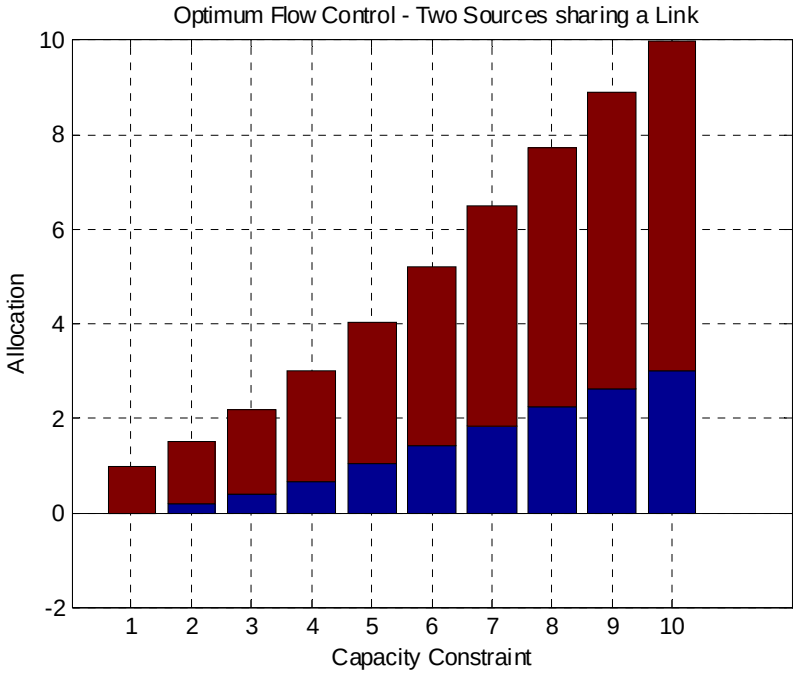
$$\begin{aligned} g(p) &= \sup_{x_s} L(x,p) \\ &= \sum_{s} \max_{x_s} \left(U_s(x_s) - x_s p^s\right) + \sum_{l} p_l c_l \end{aligned}$$

$$p^s = \sum_{l \in L(s)} p_l .$$

- If the dual-optimum price p* is sent to the nodes, each node can calculate its optimal load (rate) without revealing its (latent) utility.
- Arriving at the optimal p* can be achieved iteratively.

# Example 101 (cont)




- Convergence to optimal load (left)
- Optimal loads (right)

# 802.16m SON

- 802.16m must
  - standardize the 802.16m-specific SON primitives that will be transmitted in/out of the PHY and MAC.
  - Evaluate the need for a stand-alone SON Service Access Point (SAP)
  - Liaise with other SDOs (e.g. 3GPP) to define unified messaging methods to enable **inter-RAT** SON capabilities

# References

[1] M. Chiang et.al. “Layering as an Optimization Decomposition: A Mathematical Theory of Network Architectures”

# Proposed Text For SDD

## x. SON

### *x.x SON Services*

802.16m BS shall be able to respond or advertise SON services that it can offer.

802.16m SON service function shall respond to service requests by either RAT-dependent or RAT-independent messaging.

### *x.x RAT-independent Messaging*

802.16m shall support SON messaging towards other Radio Access Technologies (RATs). The messaging structure is TBD. [[RAT-independent messaging enables the transportation of generic information types and values that may contain 802.16m-specific primitives/messages.]]